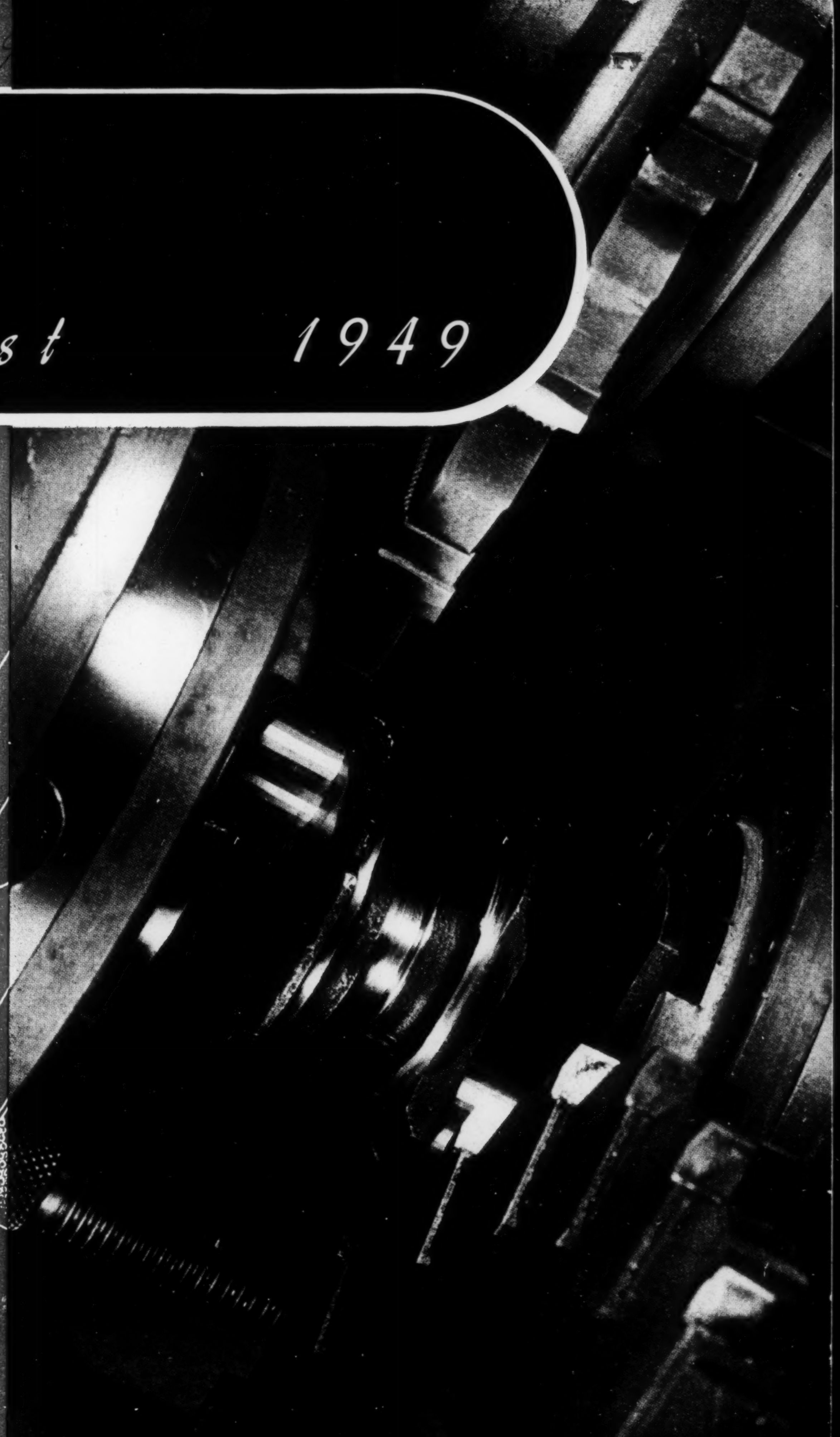
Aug-49

August 1949



In This Issue

DIALS & SCALES
BALANCING CRANKS
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CASTING DESIGN
ENGINEERING INTERNS

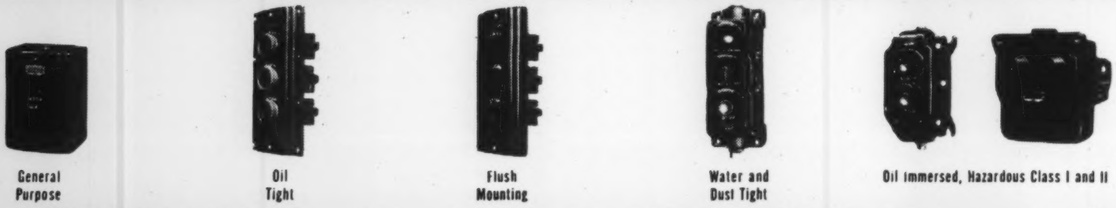
Contents, Page 3

There is no line like the C-H line OF HEAVY DUTY PUSHBUTTONS

EVERY TYPE OF OPERATOR

Plain Button Base Mounting | Plain Button One Hole Mounting | Maintained Contact Base Mounting | Latch Down Plain Button | Mushroom Head Base Mounting | Mushroom Head One Hole Mounting | Rotary Selector 2 or 3 Position | Maintained Contact One Hole Mounting | Oil-Tight One Hole Mounting | Indicating Light One Hole Mounting | Latch Safe Base Mounting

EVERY TYPE OF STATION



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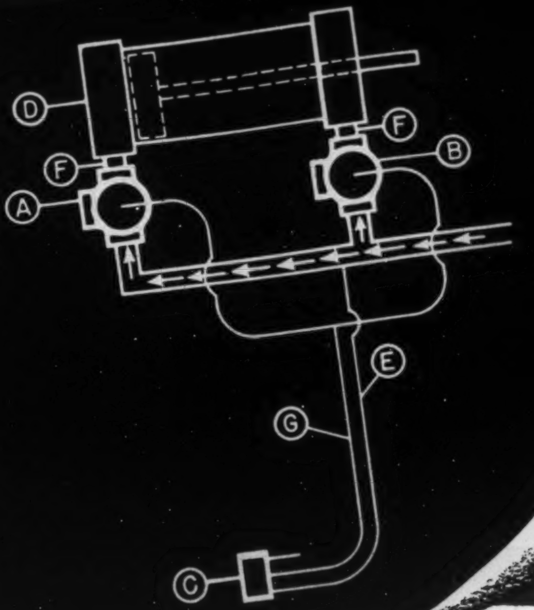

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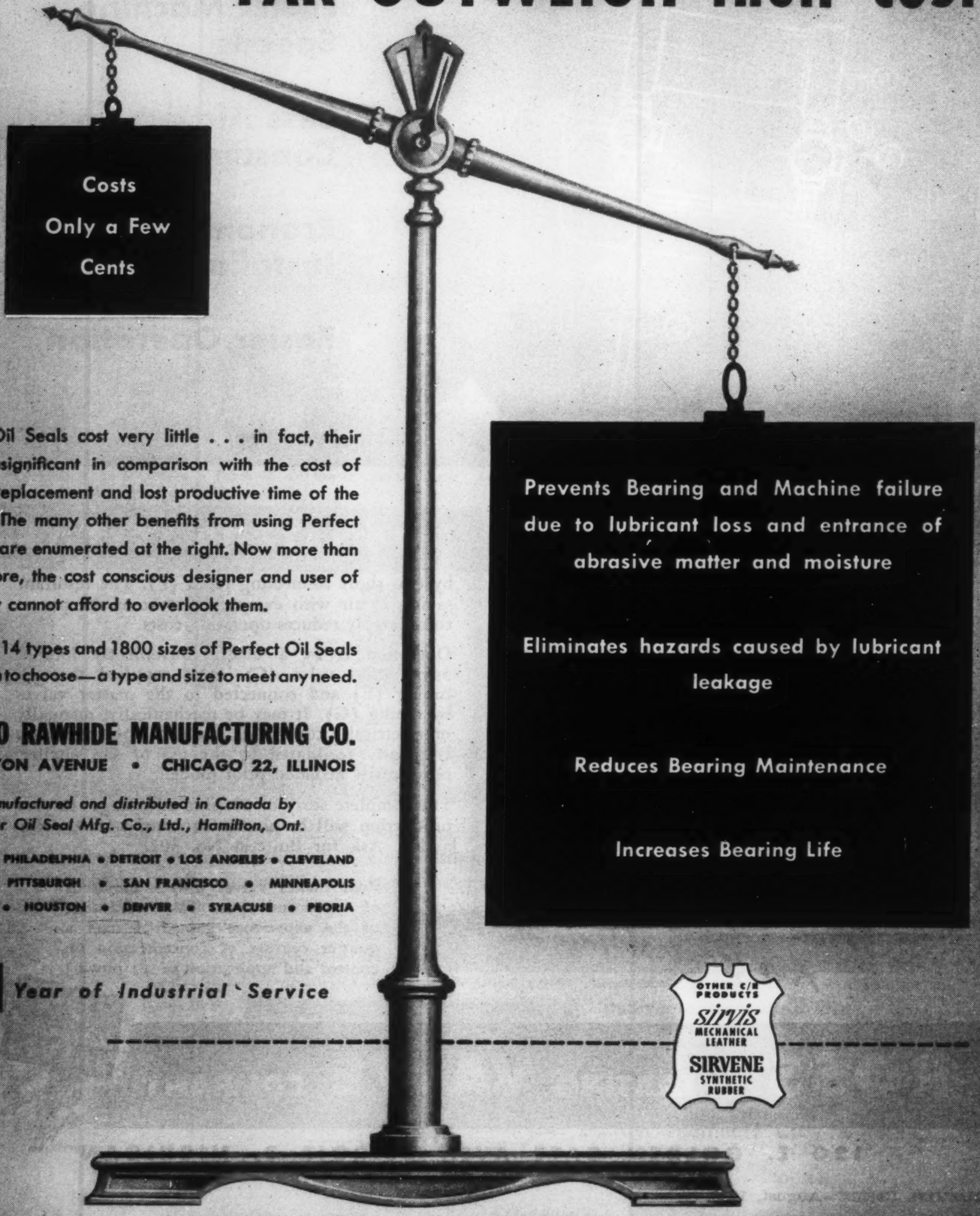
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MACHINE DESIGN

Vol. 21—No. 8 **August, 1949**

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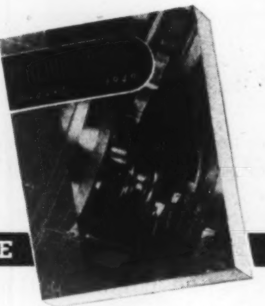

This Month's Cover: Crankshaft turn milling machine mills cheeks and throws as they rotate about the crank centerline. Interesting features of the machine are covered in the article beginning on Page 90.

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CONTENTS

Extending the Engineer's Horizon (Editorial) 89

Turn Miller—a new machine for a new process 90
By Roger W. Bolz

Scanning the Field for Ideas 95
Single-disk brake—plaster-mold castings—differential power divider—zero-drag antennas—three-margin drill

Machine Dials and Scales—designing for quick, accurate reading 98
By W. R. Garner and J. W. Gebhard

Redesigned for Eye-Appeal 105
By A. Brkich

Gas Engine Powers Portable Unit 106
By John L. Ryde

Motion Analysis—of combined rotating and sliding motion 109
By H. Dudley Wimer Jr.

Balancing Crank Mechanisms 111
By C. R. Freberg, R. C. Johnson and S. D. Moxley Jr.

What Beryllium Copper Offers the Designer 117
By John T. Richards

Oscillating Pilot Controls Valve 124
By W. J. Schupner

When Will a Toggle Snap Open? 126
By Macon Fry

Production Processes—Part XLV—Sand Casting 127
By Roger W. Bolz

Engineering Interns 141
By K. B. McEachron Jr.

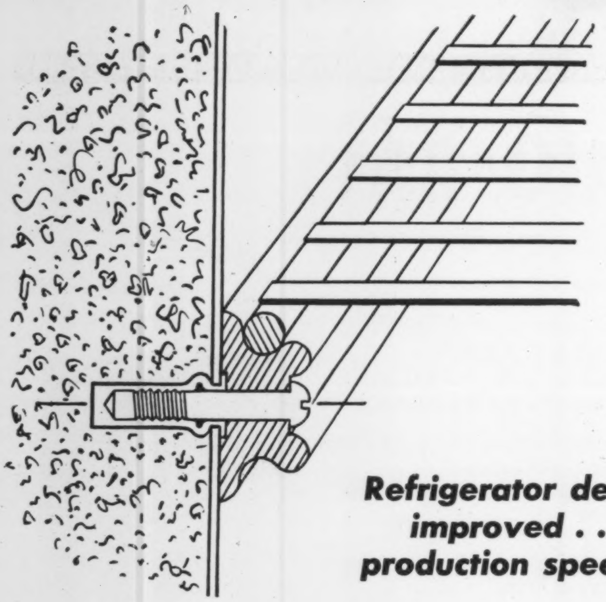
Calculating Stresses and Deflections in Circular Plates (Data Sheet) 149
By William A. Nash

DEPARTMENTS

Itemized Index 7
Topics 86
Contemporary Design 146
New Parts and Materials 151
Eng. Dept. Equipment 160
Helpful Literature 161
Noteworthy Patents 164
Men of Machines 166
The Engineer's Library 170
News of Manufacturers 176
Professional Viewpoints 186
Sales and Service Personnel 188
Sales Notes 190
Meetings and Expositions 196
Design Abstracts 198
New Machines 214

DESIGNING FOR PRODUCTION AND SALES • STYLING
MATERIALS SPECIFICATION • DESIGN ANALYSIS
MACHINE COMPONENTS • ENGINEERING MANAGEMENT

RIVNUTS solve tough fastening problem

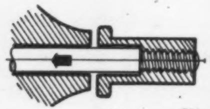
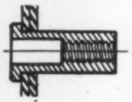
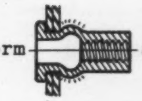
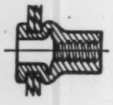
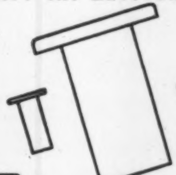
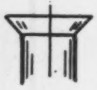
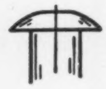
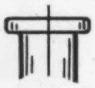


Refrigerator design improved . . . production speeded

Fastening an extruded plastic strip to the porcelainized inner wall of a refrigerator posed some tough problems for design engineers. The bucking action of conventional riveting cracked the porcelain finish. And the air-tight seal was difficult to maintain.

Both problems were quickly licked with a blind-end B. F. Goodrich Rivnut. The Rivnut was smoothly and easily upset with the heading tool. No bucking needed. No damage to the finish. The tight fit of the Rivnut combined with its closed end to provide perfect insulation. And the clean, still-intact Rivnut threads furnished an excellent nut plate for screw attachment of the plastic strip.

Rivnuts saved many man-hours. And they improved the design by providing easy maintenance of the shelf-holding strips without removing the wall. The answer to *your* tough fastening problems may lie in Rivnuts. Why not call in a Rivnut engineer? Write the B. F. Goodrich Company, Dept. MD-89, Akron, Ohio.

HOW RIVNUT WORKS: Rivnuts are upset with a heading tool (hand or hydraulic) that transmits a pull on the threaded portion  so that the counterbore  (which is thinner) has to give. A bulge starts to form  and the threads push the counterbored portion until the expanding metal seats itself firmly against the material being fastened  Rivnuts are available in a wide range of sizes  (actual size) with countersunk,  brazier,  or flat head  in aluminum, brass and steel.

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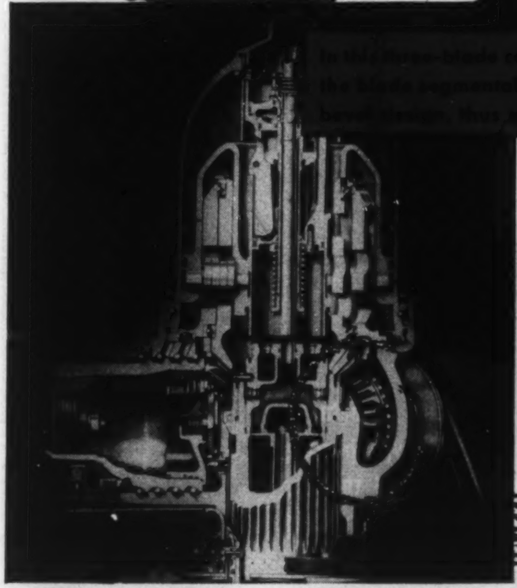

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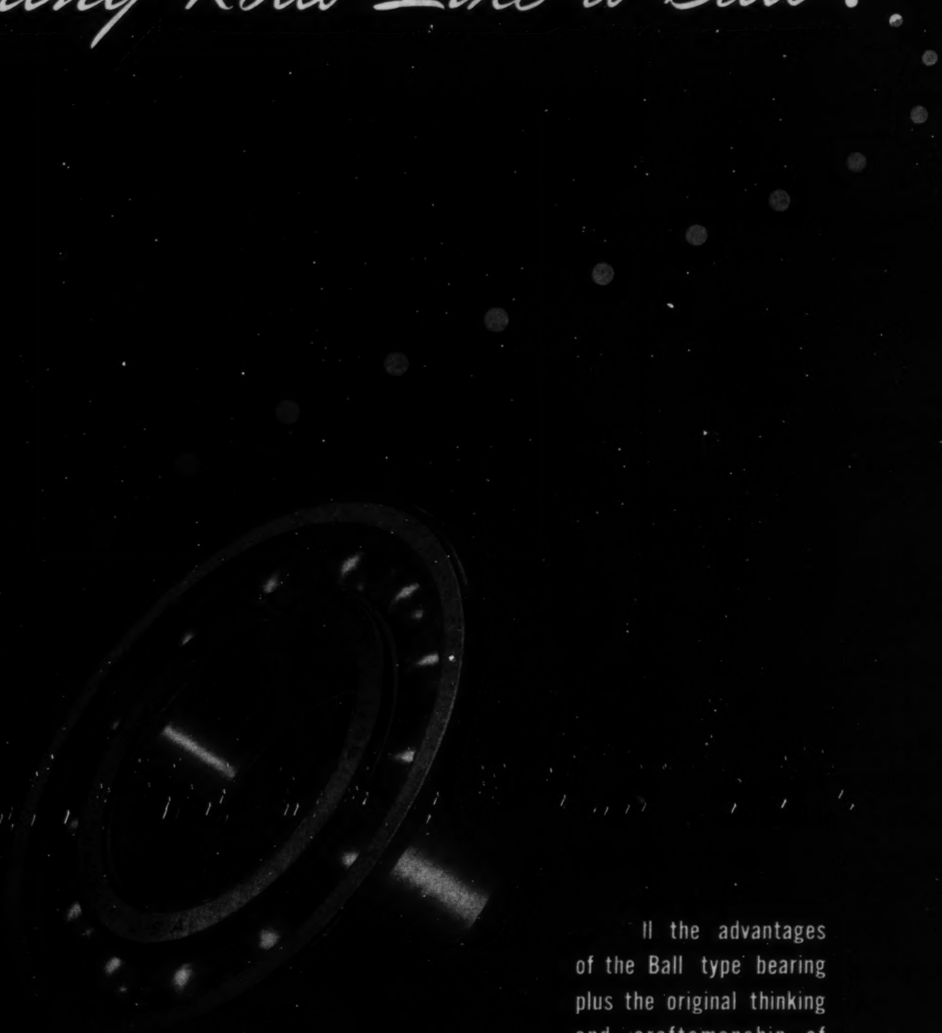

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Itemized Index

Classified for convenience when studying specific design problems

Design and Calculations

Antennas, flush mounted, Edit. 97
Balancing crank mechanism, Edit. 111-116
Cam differential, Edit. 96
Camera flash unit, Edit. 146
Drills, twist, 3-land, Edit. 97
Frameless automobile, Edit. 212
Machine dials and scales, Edit. 98-105
Motion analysis, Edit. 109-110, 180, 182, 184
Power chain saw, Edit. 106-108
Pump redesign, Edit. 105
Sand casting, design for, Edit. 127-140
Stresses and deflections in circular plate—(Data Sheet), Edit. 149-150
Toggles, dead center position of, Edit. 126
Turn miller, Edit. 90-94
Valve, solenoid-pneumatic, Edit. 124-126

Engineering Department

Equipment, Adv. 84, 85, 260, 264
Management, Edit. 140-145, 204, 206; Adv. 49
Supplies, Adv. 167, 182, 267

Materials

Aluminum alloys, Adv. 61, 82, 194, 199
Beryllium, Adv. 194
Beryllium copper, Edit. 117-123
Brass, Adv. 236, 251
Bronze, Adv. 175, 194, 243. 267
Carbon, Adv. 172
Copper alloys, Adv. 236
Felt, Adv. 248
Fiber, Adv. 76
Graphite, Adv. 42, 43, 191
Gray iron, Adv. 58, 222
Leather, Adv. 31, 57
Meehanite, Adv. 175, 239
Nickel alloys, Adv. 10
Plastics, Adv. 200
Plywood and metal laminate, Adv. 36
Rubber and synthetics, Adv. 31, 200, 253
Silicones, Adv. 174
Steel, Edit. 200, 202; Adv. 52, 53, 65, 216, 228
Steel, stainless, Adv. 227

Parts

Bearings:
  Ball, Adv. 6, 13, 83, 192, 205, 271
  Jewel, Adv. 205
  Needle, Adv. 205
  Roller, Adv. 13, 46, 83, 205, 213, 240, back cover
  Sleeve, Adv. 159, 170, 178, 205, 223, 243
  Thrust, Adv. 83, 205
Bellows, Adv. 66, 260
Belts, Adv. 40, 51, 266
Brakes, Edit. 95; Adv. 177, 231
Bushings, Adv. 214, 243, 263, 265, 269
Carbon parts, Adv. 172
Castings:
  Centrifugal, Adv. 175, 266
  Die, Adv. 18, 21, 199, 220, 261
  Investment, Adv. 55
  Permanent mold, Adv. 82, 199
  Plaster mold, Edit. 95
  Sand, Edit. 127-140; Adv. 82, 199, 222, 239
Chains:
  Conveyor, Adv. 14, 15
  Roller, Adv. 14, 15, 45, 70
Clutches, Adv. 177, 179, 211, 231, 252, 268
Compressors, Adv. 198
Controls (see Electric, etc.)
Counters, Adv. 255
Couplings, Adv. 59, 184, 247, 252, 268
Cylinders, Adv. 27, 60, 87, 210, 256, 258
Differentials, Edit. 96
Electric Equipment:
  Brush holders, Adv. 263
  Circuit breakers, Adv. 50
  Connectors, Adv. 48
  Contactors, Adv. 248
  Controls, Adv. 24, 75, 78, 79, 209, 230
  Rectifiers, Edit. 208, 210; Adv. 75
  Relays, Adv. 207
  Rheostats, Adv. 189
  Sockets, Adv. 252
  Starters, Adv. 71, 72, 74, 188
  Switches, Adv. 235
  Thermostats, Adv. 245
  Timers, Adv. 8
  Transformers, Adv. 250, 258
  Voltage regulators, Adv. 25
Electric generators, Adv. 12, 230
Electric motors, Adv. 11, 12, 24, 38, 54, 56, 88, 168, 201, 203, 204, 215, 217, 218, 230, 249, 254, 257, 265, 267, inside back cover
Engines, Adv. 222, 261
Fans, Adv. 224
Fasteners:
  Locking, Adv. 264
  Nuts, bolts, screws, Adv. 4, 28, 30, 39, 41, 173, 180, 224, 242, 250, 274
Filters, Adv. 183, 260
Fittings, Adv. 22, 163, 165
Floor plate metal, Adv. 190
Forgings, Adv. 251, 268
Gages, pressure, etc., Adv. 32
Gears, Adv. 23, 64, 218, 220, 232, 238, 264
Generators, (see Electric generators)
Graphite parts, Adv. 42, 43, 191
Heaters, Adv. 241
Heat exchangers, Adv. 234
Hose (see Tubing)
Hydraulic equipment:
  Accumulators, Adv. 206
  Controls, Adv. 258
  Cylinders, Adv. 27, 60, 87, 210, 256, 258
  Motors, Adv. 258
  Pumps, Adv. 26, 60, 193, 208, 248, 256, 258, 266, 269
  Steering assemblies, Adv. 35
  Valves, Edit. 124-126; Adv. 1, 22, 60, 208, 246, 254, 256, 257, 258
Joints, Adv. 63
Lubrication and equipment, Adv. 62
Magnetos, Adv. 229
Magnets, permanent, Adv. 20
Motors (see Electric motors)
O-rings, Adv. 195
Plastic parts, Edit. 148
Plugs, Adv. 252
Pneumatic equipment:
  Controls, Adv. 260
  Cylinders, Adv. 87, 210
  Lubricators, Adv. 260
  Pumps, Adv. 193, 208
  Valves, Edit. 124-126; Adv. 1, 22, 208, 254
Powder-metal parts, Adv. 187
Pulleys and sheaves, Adv. 79
Pumps (see also Hydraulic and pneumatic), Adv. 26, 60, 105, 193, 208, 212, 256, 269
Pushbuttons, Adv. inside front cover
Rubber and synthetic parts, Adv. 253
Seals, packings, gaskets, Edit. 125; Adv. 2, 29, 31, 42, 43, 57, 80, 195, 219, 244, 246
Shafts, flexible, Adv. 266
Sheaves, Adv. 24, 25, 269
Shims, Adv. 202
Speed changers, Adv. 25, 197
Speed reducers, Adv. 77, 81, 225, 250, 258
Springs, Adv. 16, 17, 226, 257
Sprockets, Adv. 70
Terminal boards, Adv. 246
Transmissions, fixed ratio, Adv. 67
Transmissions, variable speed, Edit. 208, 210; Adv. 9, 79
Tubing:
  Flexible, Adv. 37, 176, 185, 221, 265
  Metallic, Adv. 37, 181, 221, 233
  Nonmetallic, Adv. 176
  Structural, Adv. 65, 169, 171, 181, 196, 221
Universal joints, Adv. 261, 264, 265
Valves, (see also Hydraulic and pneumatic), Edit. 124-126; Adv. 1, 22, 60, 208, 246, 254, 256, 257, 258
Washers, Adv. 48
Weldments and equipment, Adv. 68, 226, 237
Wheels and casters, Adv. 64, 254
Wire and wire products, Adv. 10, 186

Production

Balancing, Adv. 69, 263
Facilities, general, Adv. 19, 218, 273
Gear grinder, Adv. 5
Machines, special, Adv. 44, 73
Tools and accessories, Edit. 147

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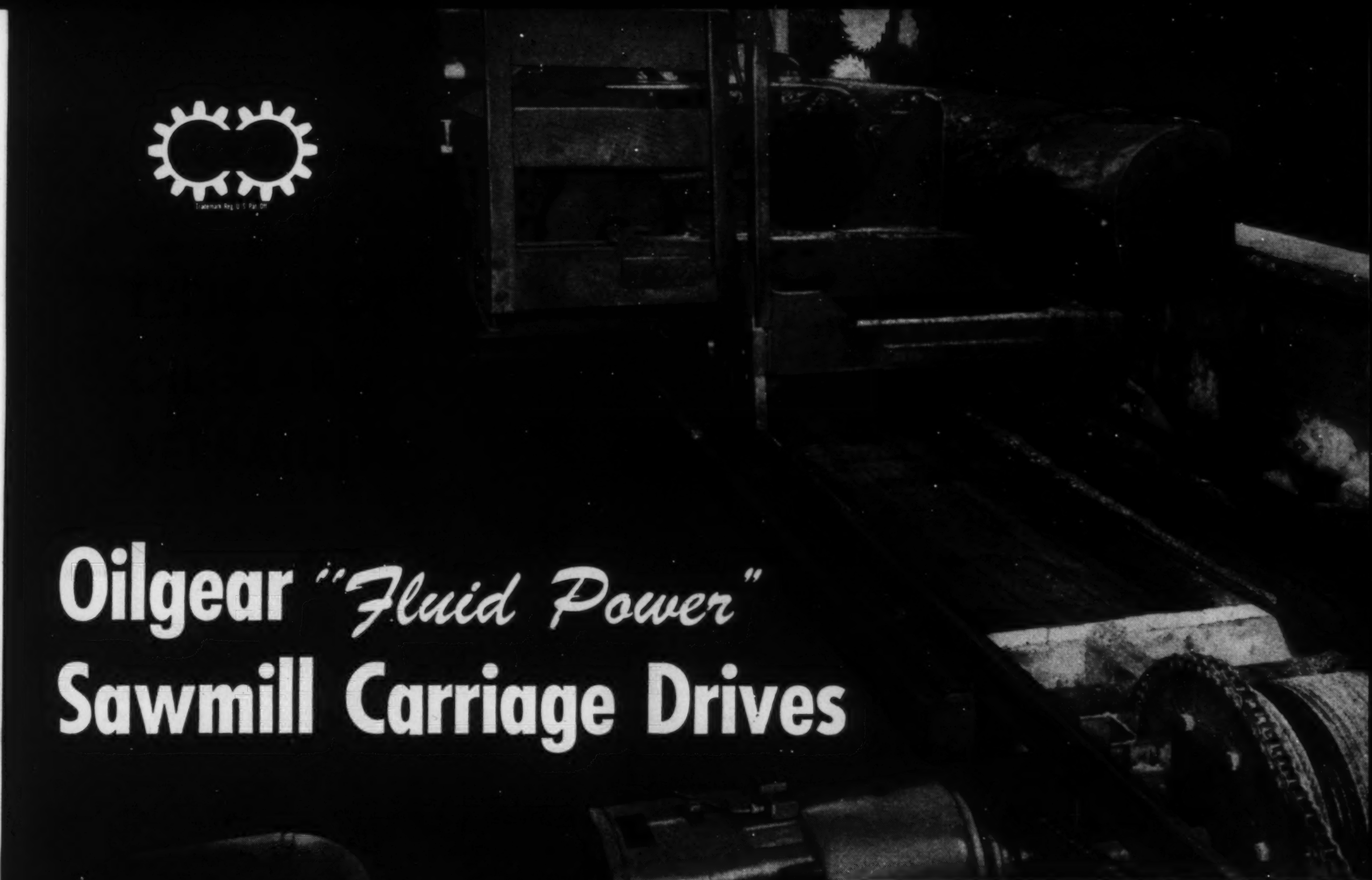
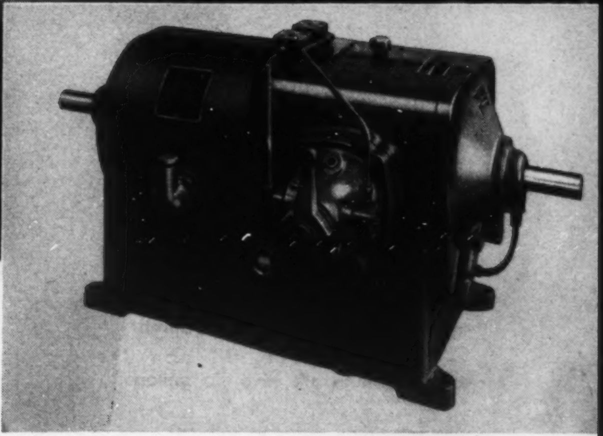


Oilgear "*Fluid Power*" Sawmill Carriage Drives



Oilgear 20 H. P. Two-Way Variable Speed Transmission for Sawmill Carriage Drive.

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Second, there's no power plant, no auxiliary equipment, no generator set, no complicated, easy-to-get-out-of-order control mechanism. Nothing can hurt these battleship-built drive units which have proven successful for over a quarter century on other tough drives. Using available alternating current, you convert wood waste to profit instead of fuel, and need no steam engineer.

Third, its operating mechanism is fully enclosed and automatically lubricated. No frequent servicing necessary. Merely change oil every 4 to 8 months.

Oilgear Fluid Power equipment is also used on gang saw feed rolls, set works and holding dogs, edgers, conveyors, veneer lathes, surfacers, hot plate presses and baling presses. In the pulp and paper industry it is used on paper machine drives, calender drives, winder drives, unwinder drives, hold-down systems.

Any machine designer, any manufacturer, can investigate versatile, profitable Oilgear to advantage. THE OILGEAR COMPANY, 1568 W. Pierce St., Milwaukee 4, Wisconsin.

Oilgear Fluid Power

A 29¼-lb. rainbow trout caught by Carl Haacke at Lake Pend Oreille, Idaho with a Monel line—one of the six biggest fish caught on Monel line which won awards in the Field & Stream Contest.

How to get the Big Ones . . . 'Way Down Deep

Fishermen used to have a devil of a time hooking fish like this in hot weather.

Trouble was that big fish like to stay away down on the cool lake bottom. Ordinary trolling line just wouldn't go down there.

All sorts of gadgets were tried. Trick sinkers and attachments were devised to get the hook down where the fish could grab it. The lines themselves were coated with heavy substances to make them sink.

Finally, *metal* lines were given a trial. They went down all right. But other difficulties came up.

They were too heavy. Too thick, too awkward altogether. To be flexible enough for easy handling, the wire line had to be light and fine. To be fine, the metal had to be very strong.

The metal also had to be rustless . . . corrosion-resisting . . . and tough to stand the twisting, diving, leaping yanks of a fighting fish.

Then the news came down from the "big muskie" lakes of Canada about the discovery of a line that revolutionized deep trolling: MONEL Line.

Today wherever you see sport fishermen trolling for the big ones way down deep you find them using Monel lines . . . and catching the biggest fish of all in the hot summer months when fishing used to be "dead."

Perhaps, like the manufacturer of trolling line, your problem is one of wire. Outline your task to us. We'll forward samples of recommended wire for test. Monel and all the Inco Nickel Alloys are the "task metals" of industry . . . ready to help whenever you need tough metals for tough jobs. They're available in all forms.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

If You Are a Fisherman . . .

You are welcome to a copy of Fred Streever's new booklet, "A NEW FISHING TECHNIQUE," in which the master himself tells how to catch more and bigger fish by deep trolling with wire line. Tells what lines are best: what rigs to use: information on rods, reels, depths, and feeding grounds for different fish, and tricks of the expert. Write Sporting Goods Section of Inco for your copy.

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Monel • "K"* Monel • "R" Monel • "KR"* Monel • "S"* Monel Nickel • "D"* Nickel • "L"* Nickel • Duranickel* • Permanickel* Inconel* • Inconel "X"** *Reg. U. S. Pat. Off.

"Task Metals" for Industry

Baldor
Nationally Approved by Industry

motors that add impressive Selling Points to the product — and please the End-User

☑ **100% TOTALLY ENCLOSED.** Baldor Streamcooled Motors are completely enclosed and fully protected against internal damage. They're dust-proof, drip-proof and vermin-proof.

☑ **COOL-RUNNING.** An outer-mounted fan forces cooling air over the entire exterior of the motor.

☑ **NON-CLOGGING.** These motors cannot inhale dust, dirt, lint or other contamination. There is no air-passageway to clog up and cause burnout or lowered efficiency. No dismantling for cleaning—no interruption of production.

☑ **QUIET, SMOOTH OPERATION.** Baldor Motors are of perfectly balanced design which assures quiet, smooth operation.

☑ **CLASS A or B INSULATION.** All Baldor Motors are of ball-bearing construction and are furnished with either Class A or B insulation.

☑ **INDIVIDUALLY TESTED.** Each motor receives a thorough commercial test before leaving the plant.

☑ **NATIONALLY SERVICED.** Baldor Motors are sold and serviced in more than 200 Trade Centers.

BALDOR ELECTRIC COMPANY

ST. LOUIS and other Principal Cities

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STREAMCOOLED MOTORS
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MOTOR SPECIALISTS 29 YEARS

Powerful New Source of Sonic Energy

Ultrasonic Corp. Model U-4 Sonic Generator

Over 300 watts of acoustic energy—at an intensity level of 165 decibels—produced by this EEMCO-powered sonic generator

A Special EEMCo Motor for a Special Duty

One of many powering problems solved by EEMCO

We have solved the widely varying electric drive problems of manufacturers of ultrasonic sound generators, oil well recovery tools, power saws, radar equipment, submersible pumping units, dairy homogenizers, ultracentrifuges, and aircraft. Our specialty is tough problems of function, power, size, weight, shape, performance, installation, and operation.

This is the most powerful gas phase source of sonic energy commercially available. Only 28 inches overall, and extremely simple and compact, this sonic generator produces over 300 watts of acoustic power. This equipment was developed by *Ultrasonic Corp.*, Cambridge, Mass., for use in industry and research. Dust and mist collection, destruction of bacteria, and increasing seed germination are a few of many interesting applications.

EEMCO engineers developed the special motor application for this unit, meeting severe demands of compactness, operational simplicity, and flexibility. The 1½ hp *EEMCO* universal type, explosion-proof motor operates at the wide speed range of 5400 to 18,000 rpm (with Variac speed control). Extremely close concentricity of the special mounting adaptor with the output shaft was required . . . and was achieved with a tolerance of 1/1000 inch.

Design ingenuity and production skill . . . this is the gratifying combination you get in *EEMCO* services. Let us consult with you on your current motor problems.

EEMCo

ELECTRICAL ENGINEERING and MANUFACTURING Corp.
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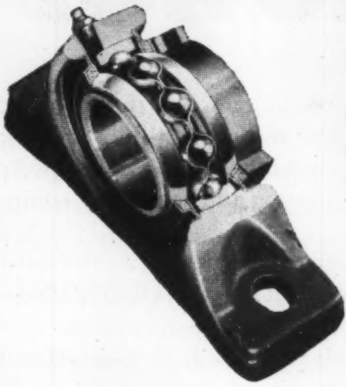
SPECIAL MOTOR DESIGN — DEVELOPMENT — MANUFACTURING

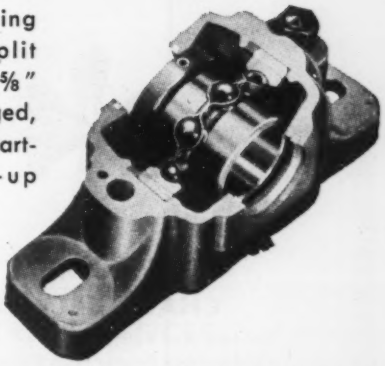
LINK-BELT offers the "QUALITY QUINTET" in BALL AND ROLLER BEARINGS

Series 200 ball bearings



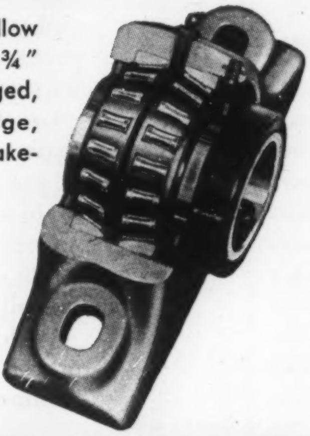
Solid or split housing pillow blocks (solid shown) for shafts $\frac{5}{8}$" to $3\frac{15}{16}$"—also flanged, take-up, and hanger blocks.

Series 300 ball bearings



Solid or split housing pillow blocks (split shown) for shafts $\frac{5}{8}$" to $3\frac{15}{16}$". Also flanged, flanged cartridge, cartridge and take-up blocks.

Series 400 roller bearings



Solid housing pillow blocks for shafts $\frac{3}{4}$" to 4"—also flanged, flanged cartridge, cartridge and take-up blocks.

Series 6800-6900 roller bearings

Split housing pillow blocks with adapter sleeves for mounting on commercial shafting of $1\frac{7}{16}$" to $6\frac{15}{16}$" diameter.

Series 7800-7900 roller bearings

Split housing pillow blocks for press-fit on precision-turned shafting of 1.7700" to 7.4800" diameter.

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Indianapolis 6, Chicago 9, Philadelphia 40, Atlanta, Dallas 1,
Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4,
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LINK-BELT
BALL AND ROLLER
BEARINGS

Have you looked for lower

If you're designing for lower costs, consider these points. Have you thoroughly explored the possibilities for cost reduction and improved performance offered by properly applied power transmission, timing, and conveying equipment?

Perhaps you're using the same basic design . . . the same type equipment for these important functions that has been used for years.

Maybe it's still the best, but you owe it to yourself and your customer to be sure that the product you use is the lowest in cost, consistent with quality and performance.

For example, your design may be overchained. A lighter chain may do the job just as well with important savings to you and the customer. A cast chain instead of a steel chain again may do the job as well at lower cost.

Conversely, your design may be underchained and liable to premature breakdown, resulting in far greater overall cost to you and your customer.

Perhaps you are using other methods of transmitting power or timing operations and a chain drive can effect substantial savings in space, costs and weight.

THE COMPLETE CHAIN BELT LINE

Baldwin-Rex Roller Chains
Baldwin-Rex Double Pitch Roller Chains
Baldwin-Rex CPS Flat Top Chains
Rex Cast & Steel Detachable Chains
Rex Pintle Chains
Rex H-Type Drive Chains
Rex H-Type Conveyor Chains
Rex Refuse & Log Haul Chains
Rex Transfer Chains
Rex Ley Bushed Chains
Rex Combination Chains
Rex Durobar Chains
Rex Cast Roller Chains
Rex Double-Flex Chains
Rex Sugar Mill Chains
Rex Chabelco Steel Chains
Rex Offset Side Bar Roller Chains
Rex Table Top Conveyor Chains
Rex Drop Forged Chains
Rex Drag Chains
Rex Cast Sprockets
Baldwin-Rex Cut Tooth Sprockets
Baldwin-Rex Flexible Coupling
and a complete line of chain attachments.

CHAIN BELT REX COMPANY

CHAIN BELT COMPANY

HERE*

costs?

There is no one best or stock answer to the problem of transmitting power, timing operations or conveying materials. That is why we at Chain Belt Company feel that we can be of practical assistance to you in designing for lower cost. Because we manufacture a *complete line of chains,* both cast and steel, we can help you select the chain that is exactly right for your machines.

If the operating conditions are such that a cast chain is indicated, we have the exact chain that will best fit the need. Where speeds and horsepower requirements demand a finished steel roller chain, again our complete line contains the answer.

Our Field Engineers plus our Plant Engineers are well equipped to work with you in the selection and application of Rex and Baldwin-Rex Chains for your designs. In many instances they have been able to help effect substantial savings and increase machine efficiency through the flexibility of our complete line and their years of practical experience. Call or write the Chain Belt Company Field Office near you or write direct to Chain Belt Company, 1643 West Bruce Street, Milwaukee 4, Wis.

*

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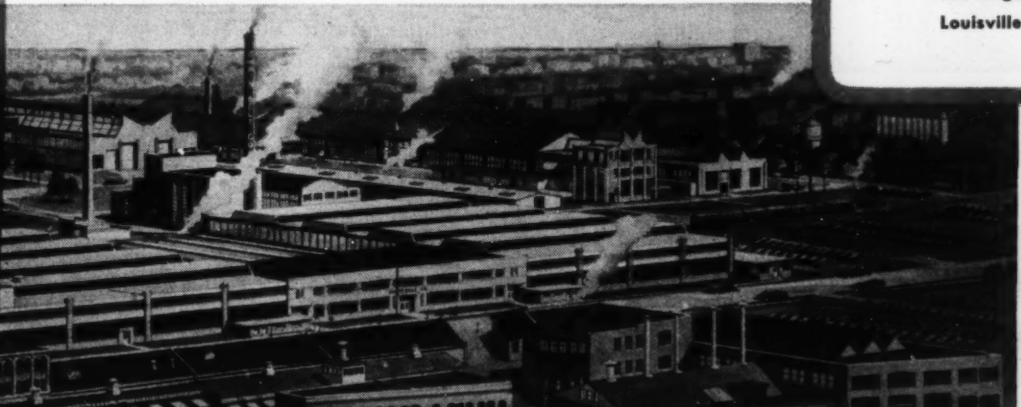
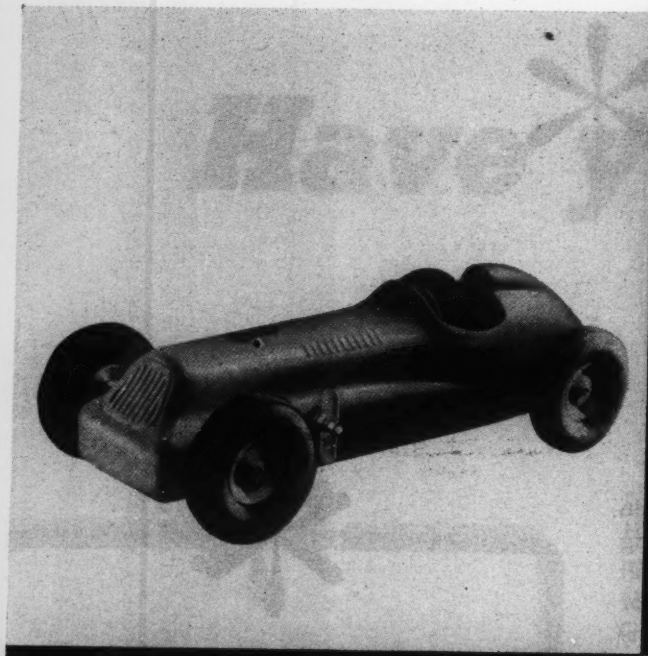


Here is a composite view of Chain Belt Company's manufacturing facilities. From these plants comes a line of chains unsurpassed for completeness . . . chains that have been serving industry everywhere for over 50 years.

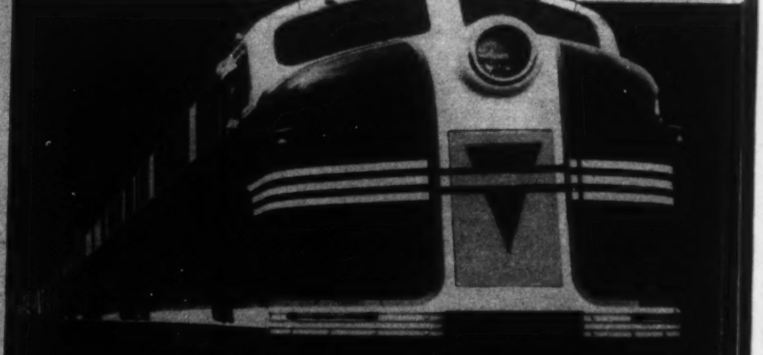
BALDWIN-DUCKWORTH DIVISION
Springfield 2, Massachusetts

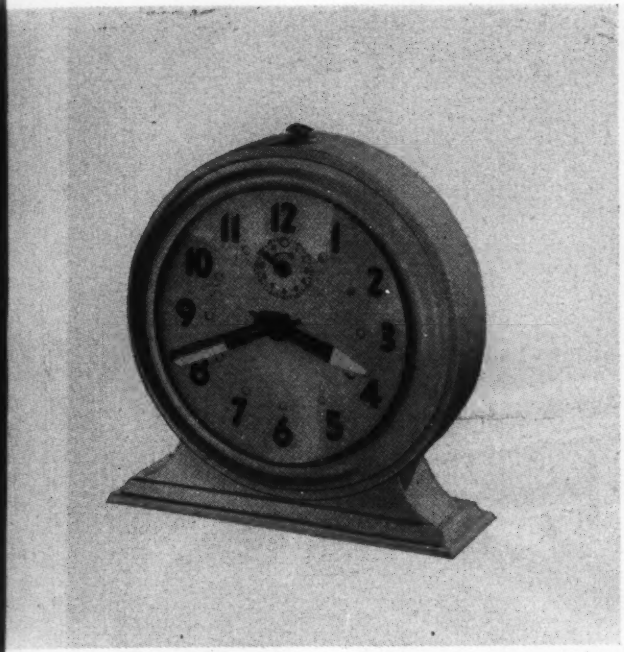
REX CHAIN & TRANSMISSION DIVISION
Milwaukee 4, Wisconsin

BALDWIN-REX



American





Clocks? Cars? Trains?
Sure!—but they're
just a few
of the places
where you'll find

Quality Springs

● American Quality Springs are also playing an important role in farm equipment . . . in washing machines . . . in phonographs . . . typewriters . . . window shades . . . grass cutters . . . overhead garage doors . . . textile machinery . . . and hundreds of other items where *spring* performance often determines *product* performance.

And the chances are that where you find equipment with American Quality Springs, you'll hear some mighty enthusiastic reports about product performance. For these carefully made springs have done outstanding jobs under all kinds of adverse (as well as everyday) operating conditions.

In some applications American Quality Springs have been subjected to high stresses. In others they have been confronted with severe corrosive conditions. Still others have placed them under extreme changes of temperature. Yet they have maintained for years, an enviable reputation for *doing the job right.*

Whether your spring application presents a particularly knotty problem of space, size or function, or is just an everyday use—whether you need giant hot wound springs or tiny helicals—we offer you the same attention of our engineers . . . the same painstaking care in design . . . the same safeguarding of quality . . . the same promise of top performance.

AMERICAN STEEL & WIRE COMPANY, GENERAL OFFICES: CLEVELAND, OHIO
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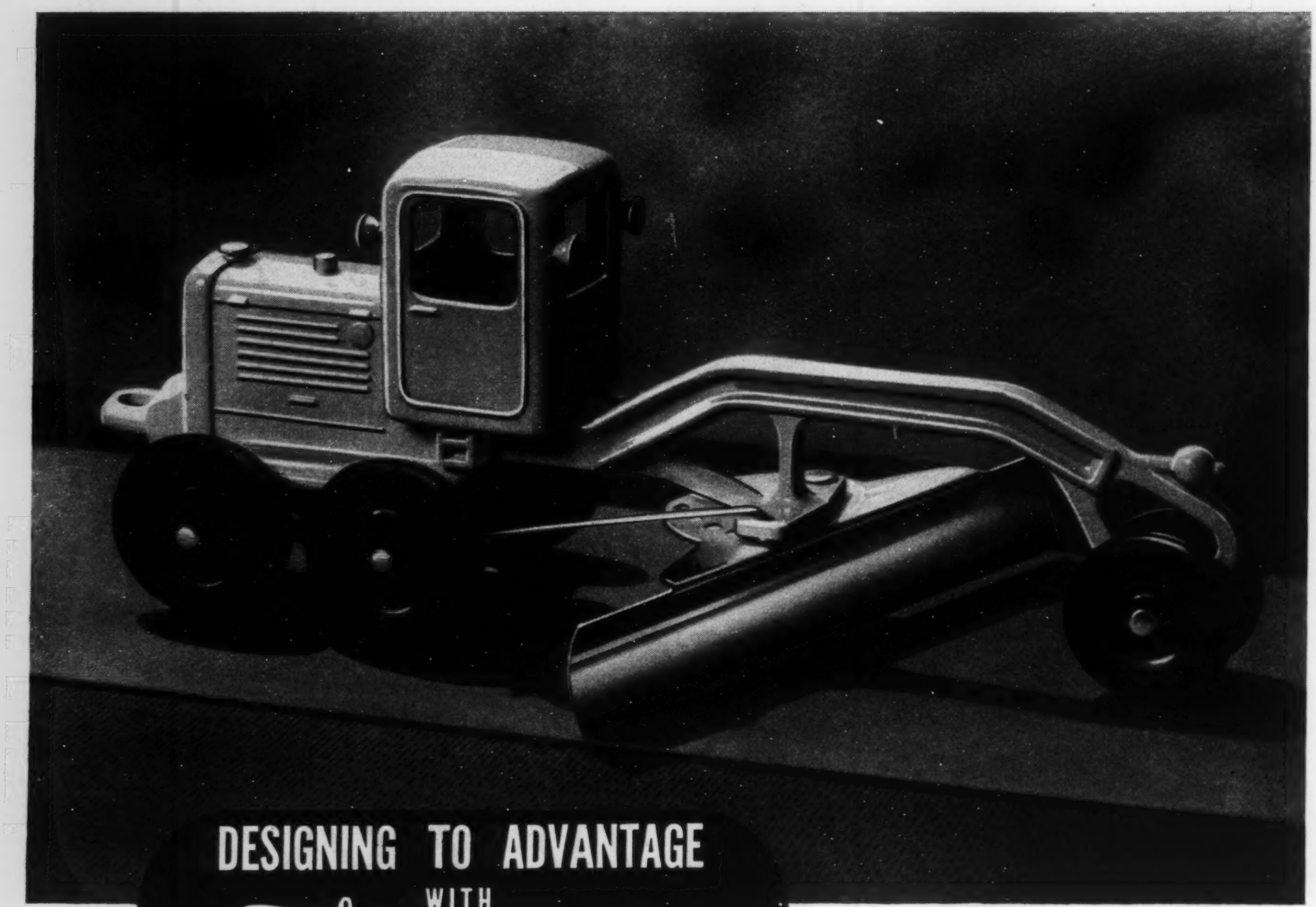
USS **AMERICAN QUALITY SPRINGS**

UNITED STATES STEEL



DESIGNING TO ADVANTAGE
WITH
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Aluminum Slik-Toy Grader made by Lansing Co., Inc., Lansing, Iowa.

IN ALUMINUM AND ZINC DIE CASTINGS

by **MADISON-KIPP**

Slik-Toy designers are cost, weight and strength conscious when selecting materials. They have produced a virtually indestructible grader with Madison-Kipp die castings. There are many applications in industry for the same kind of results and probably some in your business. Please send all inquiries to our home office in Madison, Wisconsin.

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ANCIENS ATELIERS GASQUY, 31 Rue du Marais, Brussels, Belgium, sole agents for Belgium, Holland, France, and Switzerland.

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ACCURACY

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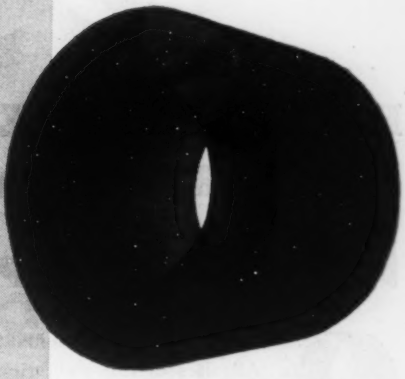
WEAR RESISTANCE

What *Qualities* do you look for in Non-Ferrous BEARINGS and CASTINGS?

You want ALL FOUR, of course . . . and you get ALL FOUR qualities plus better performance and greater long-range economy when you specify N-B-M Bearings and Castings.


SHOCK RESISTANCE

The bearings and castings shown above are typical results of these complete—and modern—facilities that you'll find at National Bearing Division:

Research—

American Brake Shoe's extensive research labs, containing the latest in testing equipment, are always at the disposal of N-B-M for all types of research on customers' problems.

Engineering—

The N-B-M Engineering staff is fully qualified to work either for or with you in solving problems of stress, alloy or over-all design of bearings and castings.

Production—

From precision molding to final machining, N-B-M has the latest manufacturing techniques that assure you of products with maximum strength, precision, wear-resistance and density.

Quality Control—

Modern X-Ray, Photomicrographing equipment, and other latest testing devices provide a surety for you of castings that meet and often exceed your specifications.

Yes, if qualities that insure longer, more economical service are important for the Bearings and Castings used in your plant or product, call in your nearest N-B-M Representative. He will be glad to give you specific information on how this complete N-B-M service can be applied to your problems.

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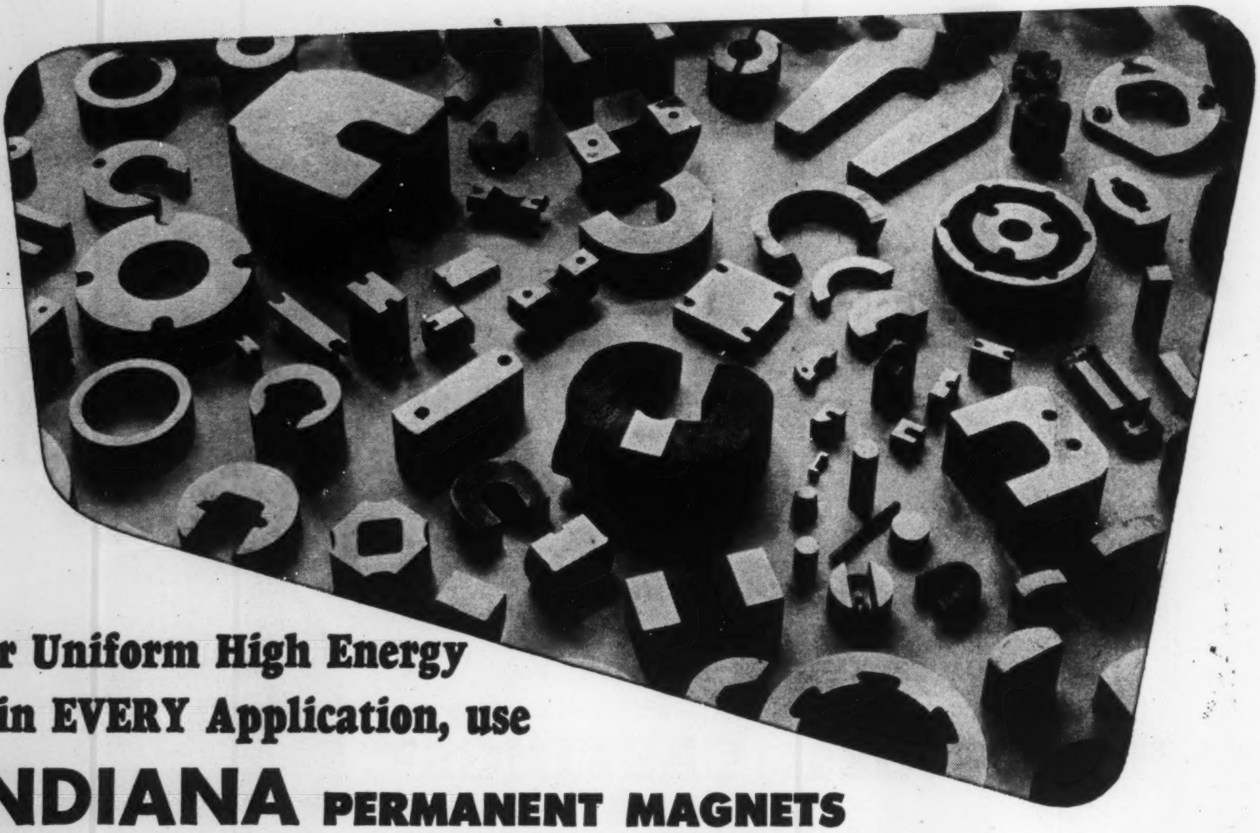

For Uniform High Energy in EVERY Application, use

INDIANA PERMANENT MAGNETS

THIN-WALL ALNICO RINGS

All sizes of thin-wall, ring-type permanent magnets for television focus coils. Indiana quality assures a strong magnetic field.

"ION-TRAP" PERMANENT MAGNETS

Permanent magnets to deflect electrons out of the ion-electron stream. Made of Alnico and Cunife in all diameters and forms.

PERMANENT MAGNETS FOR PHONOGRAPH PICK-UPS

Indiana permanent magnets for transforming mechanical energy into electrical energy cover the full range of physical properties, sizes, and shapes. For phonograph pick-ups, microphones, electric organs, etc.

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Indiana permanent magnets for transforming electrical energy into mechanical energy in loud speakers, telephone receivers, polarized vibrators, electric clocks, etc. Indiana has the right permanent magnet for each need.

PERMANENT MAGNETS FOR INSTRUMENTS, RELAYS, AND CONTROLS

A complete variety for ammeters, galvanometers, light meters, voltage regulators, switches, polarized relays, etc. Indiana brings you the latest methods and techniques.

PERMANENT MAGNET SUB-ASSEMBLIES

Assemblies, of which the permanent magnet is a part, designed to meet your specifications. Furnished for all requirements.

● Look to INDIANA for *quality* permanent magnets—for skill in manufacture—for cost-cutting engineering aid. Strict supervision in every step of production is your assurance of exact magnetic and mechanical characteristics.

ALL MATERIALS • ALL SIZES • ALL SHAPES

INDIANA—the world's largest exclusive producer of permanent magnets, and the only manufacturer furnishing *all commercial grades* of permanent magnet alloys—has the know-how and facilities to develop and produce the permanent magnets you require. More than 30,000 different needs have been met successfully by INDIANA "packaged energy." Write today.

INDIANA'S wide variety of magnet alloys permits precise selection.

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Alcoa Die Castings
Help Make Sales
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Who says it's man's work?

She knows (as you do)

Women like these lightweight lawnmowers. They make grass cutting easy and take plenty of knocks without breaking. They sell by the thousands because the price is right. Alcoa Aluminum Die Castings established a sales preference in lawnmowers. They can do the same for your product. Improve its looks. Boost its performance. Lower its price. Now is the time to start planning. Ask your Alcoa sales office for the book "Designing for Alcoa Die Castings". Or write ALUMINUM COMPANY OF AMERICA, 610H Gulf Building, Pittsburgh 19, Pennsylvania.

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With the ability of the Alcoa organization come important advantages of Alcoa Die Castings themselves. They do not "creep" nor "grow". They are excellent conductors of heat and electricity. Add these advantages to a bonus of light weight and a competitive price structure.

ALCOA ALUMINUM Die Castings merit your FIRST consideration

ALCOA ALUMINUM

INGOT • SHEET & PLATE • SHAPES, ROLLED & EXTRUDED • WIRE • ROD • BAR • TUBING • PIPE • SAND, DIE & PERMANENT MOLD CASTINGS • FORGINGS • IMPACT EXTRUSIONS
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To save time on machine design ...specify piping from one complete line

ONE SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY

That, of course, is the Crane line—the world's most comprehensive selection of valves, fittings, pipe and accessories. So why look elsewhere next time you specify piping equipment? You'll find whatever you need, right at your finger tips, in your Crane Catalog.

For this "Save Condensation" Boiler System, for example . . . as for larger and more complex machinery . . . Crane is the **One Source of Supply** complete enough to simplify every piping procedure, from drafting room to your product assembly line.

Ordering and storekeeping are simplified, too . . . piping assembly operations are better controlled . . . when you give Crane **Complete Responsibility** for piping materials. And "Crane" on the piping marks your product a better buy. For your customers know that in piping equipment, Crane stands for *Highest Quality.*

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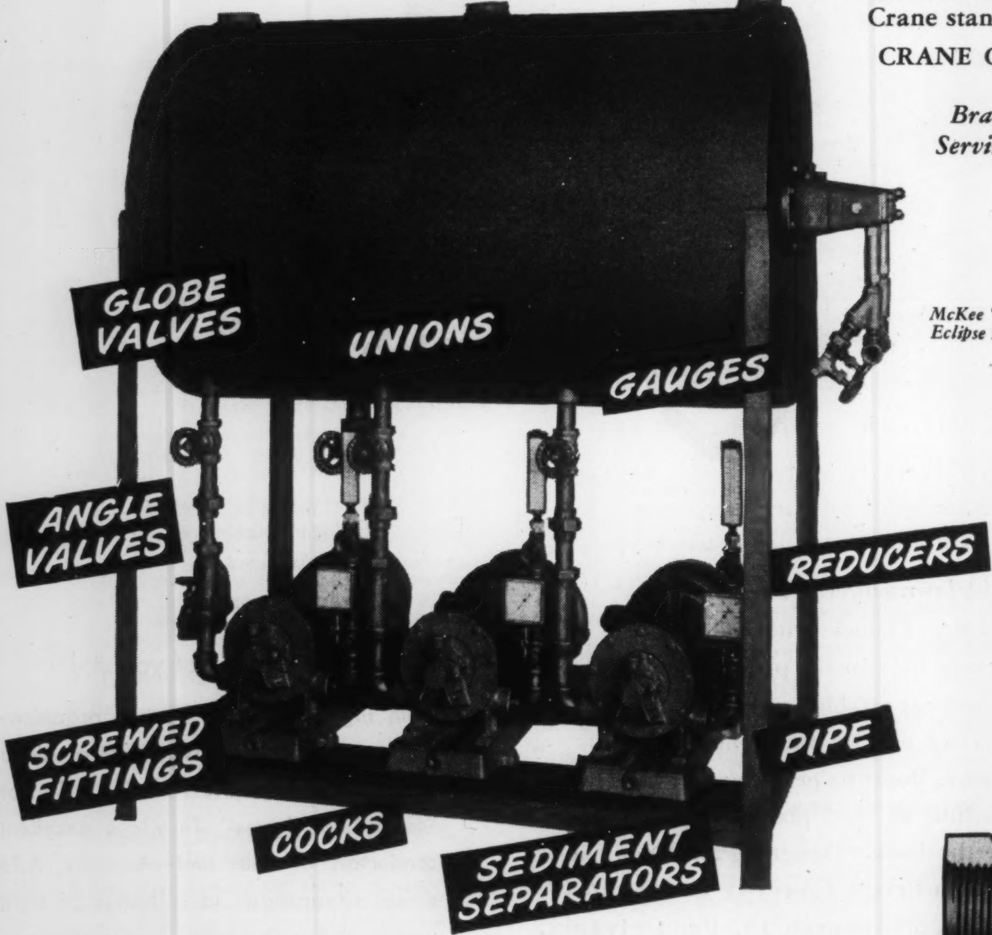
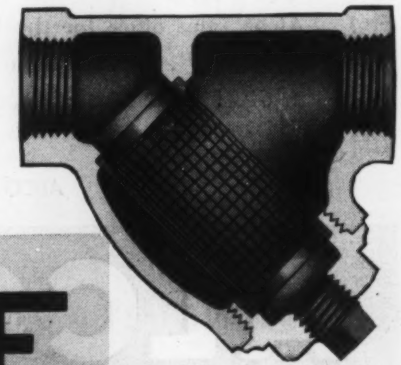


McKee "Save Condensation" Boiler System by Eclipse Fuel Engineering Co., Rockford, Ill.

FOR MAXIMUM PROTECTION *against damage from grit, dirt, scale and foreign matter in steam, water, air, oil and gas lines . . . Crane recommends vertical screen or Y-pattern sediment separators, in iron or steel. Extra large screening areas, with screen of mesh and materials best suited for service specified, assure free fluid flow and minimum pressure loss. Sizes: up to 12 in. Working pressures to 600-pounds steam. Flanged or screwed ends. See your Crane Catalog.*



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VALVES • FITTINGS
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FOR EVERY PIPING SYSTEM

DUMORE
DUO-FLEX
FLEXIBLE SHAFT TOOL

FRACTIONAL HORSEPOWER GEARING

GS

with GEARS by...

The Dumore Company of Racine, Wisconsin, widely known for the uniform excellence of their products, use G.S. Fractional Horsepower Gearing in their new Flexible Shaft Tools. "You don't have to baby them", says Dumore .. "Built for round-the-clock duty" .. "always dependable on production jobs" .. "rugged durability for high speed flexible shaft work".

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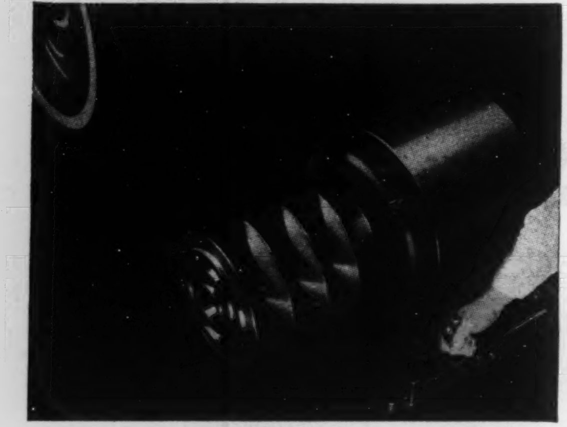
Tips on Economical

A-C ALLIS-CHALMERS

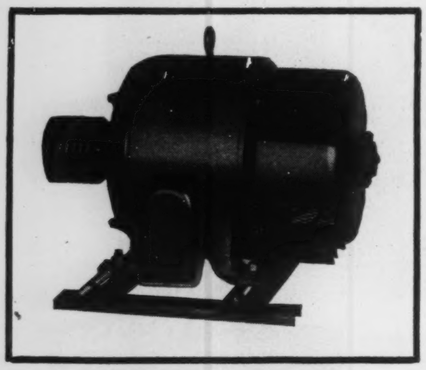


New! VARI-PITCH Automatic Sheaves

Accurate, instant speed control for most speed changing needs from 3 to 20 hp. Simply move the motor toward the driven sheave to increase machine speed . . . move it away to decrease speed. The automatic sheave does all the work. Lowest cost method of changing speeds while running.

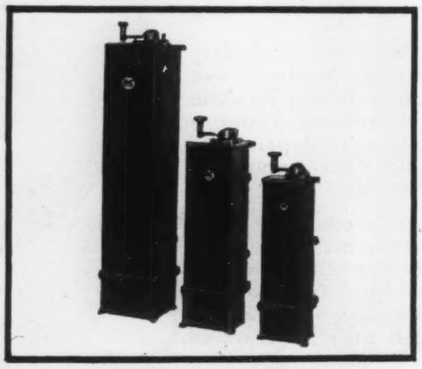
Here's a quick look at industry's widest range of adjustable speed equipment. From this line you can select a *type* of drive that will meet the exact requirements of your particular equipment . . . an *economical* drive, because you choose the *simplest, least costly* for your job!

Allis-Chalmers not only builds wide range adjustable speed equipment such as d-c motors and control, but also complete *Texrope* V-belt drives. For example, *Vari-Pitch* sheaves have a speed range of 2 to 1 per sheave . . . 4 to 1 per drive. They allow a wide range of adjustable speeds at only a fraction of the cost of other types of speed changing equipment.



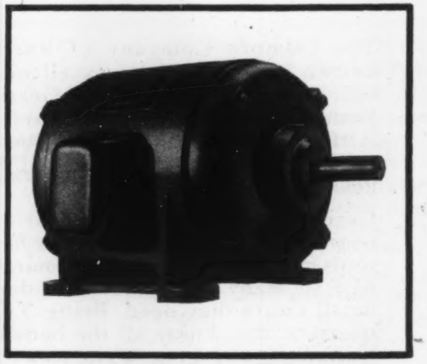
Direct Current Motors

Field resistance or armature voltage control applied to these motors give a practically stepless change of speeds over a wide range. Sizes from ½ to 200 horsepower and larger at all standard voltages. Available in such mechanical modifications as drip-proof, splash-proof and for vertical mounting. For constant and variable torque loads requiring speed adjustment.



Motor Controls

Wide range of wound rotor motor drums and resistors. Sizes from 5 to 750 horsepower in enclosed, general purpose, and semi-dust tight enclosures. For larger motors, motor operated drum controllers are available in a range of sizes. A new line of liquid slip rheostats for secondary control of wound rotor motors for use in special applications is also available.



Multi-Speed Motors

Constant torque, variable torque, and constant horsepower models in sizes from 1 to 75 horsepower. Available in either two or four speeds with overall range from 450 to 3600 rpm. Normal starting torque and current, and low starting current and high starting torque can be furnished. Combined with *Vari-Pitch* sheaves or speed changers, these motors offer wide speed range.

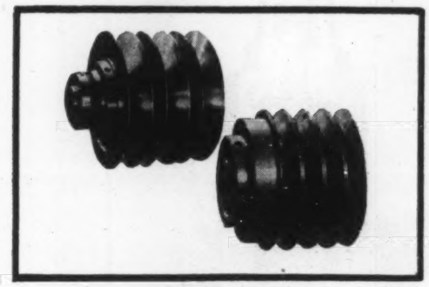
Texrope, Vari-Pitch and Regulex are Allis-Chalmers Trademarks.

Pioneers in Power and Electrical Equipment
From Generation Through Utilization

ALLIS

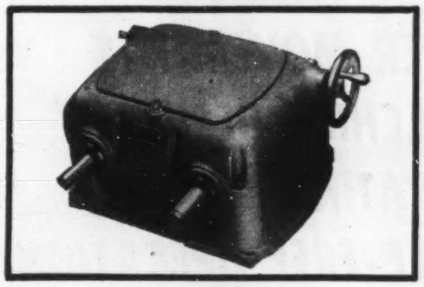
AID TO MACHINE DESIGNERS!

Adjustable Speed Drives



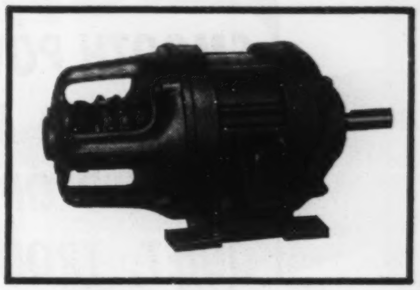
VARI-PITCH Sheaves

Standard Range *Vari-Pitch* sheaves have 15% to 25% range per sheave . . . Wide range *Vari-Pitch* sheaves 100% per sheave. Furnished in both stationary and motion control to suit application. These sheaves provide *stepless* speed changes at relatively low cost. Recommended for Textile Spinning Machines . . . Machine Tools . . . Heating and Ventilating Systems . . . others.



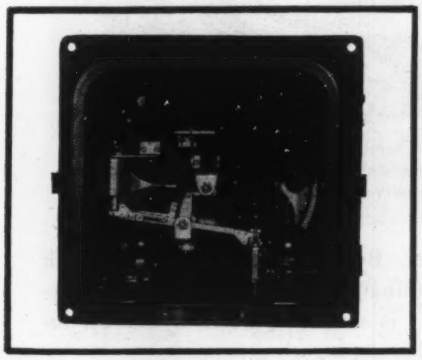
Speed Changers

Packaged speed control unit with simple handwheel for quick speed changes. Operates only in motion and provides instantly available variation of speeds through a smooth stepless range as high as 375%. Twelve sizes from 1 to 75 horsepower meet most requirements of modern machinery. This unit may also be driven through *Vari-Pitch* sheaves for even greater speed range.



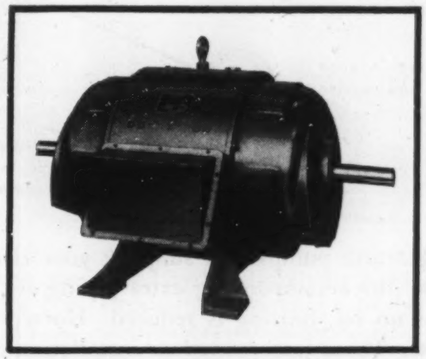
Wound Rotor Motors

For adjustable varying speed drives in sizes from 5 to 200 horsepower and larger. Wound rotor motors in conjunction with standard secondary controls offer a speed range down to 50% of synchronous speed. Starting torque characteristics of these motors make them ideal for jobs where low starting current and high starting torque are required.



Rocking Contact Voltage Regulators

Changing and holding a fixed speed on machines where the load is variable is effectively handled by Allis-Chalmers rocking contact voltage regulators. They consist of a solenoid or torque motor which rocks a hard graphite rocking contact sector against a commutator to change regulating resistance. A tachometer generator coupled to the motor shaft provides a measure of speed by supplying a voltage to the regulator coil proportional to motor speed.



REGULEX Rotating Amplifiers

Regulex amplifiers are used for speed regulation where field forcing and extremely fast response are required. *Regulex* machines provide strong corrective action because of high amplification of minute tachometer voltage changes, which has the effect of accurately and quickly controlling motor speed. These speed regulators can be used for hoists, or any drive where the load is variable and accurate speed control is needed. Can also be used for controlling almost any function of a machine which can be converted into volts, amperes or watts.

ALLIS-CHALMERS, 1001A SO. 70 ST.
MILWAUKEE, WIS.

Please send me the literature checked below:

Handy Guide for Electric Motors —
Bulletin 51B6052 ☐

Rocking Contact Voltage Regulators
Bulletin 14B6035 ☐
Bulletin 14B6143 ☐
Bulletin 14B6137 ☐

***Regulex* Amplifiers —**
Catalog Section 6050 ☐

***Vari-Pitch* Sheaves—Bulletin 20B6082** ☐

Speed Changers—Bulletin 20B6013 ☐

Switchgear and Control Devices
Bulletin 25B7095 ☐

Automatic *Vari-Pitch* Sheaves
Section 20P50 Part 4 ☐

Pre-Engineered Texrope Drives
Bulletin 20B6956 ☐

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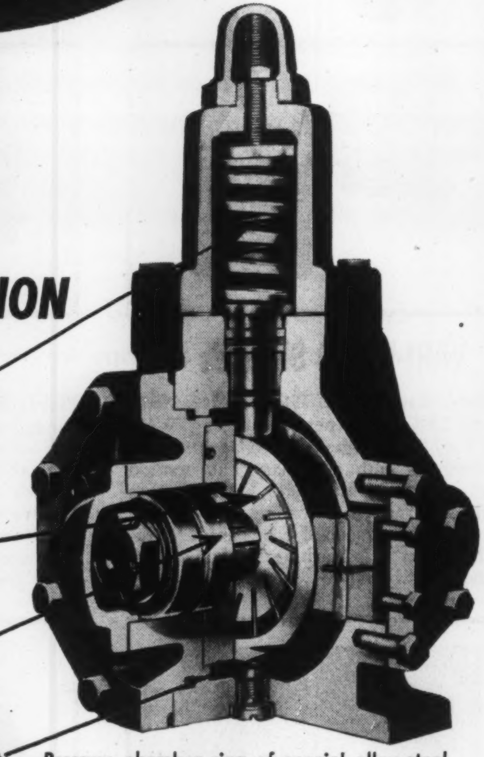
Hydraulics... FOR

SMOOTH POWER MOVEMENTS
IMPROVED MACHINE DESIGN
REDUCED OPERATING COSTS
QUIET, TROUBLE-FREE OPERATION



1 Spring governor provides automatic volume control, supplying only the needed flow of oil at a pre-determined pressure.

2 Tilted vanes cannot seize or gouge the pressure chamber ring. Constant efficiency is maintained.

3 Heavy duty pump shaft is mounted in anti-friction bearings for long life and power saving operation.

4 Pressure chamber ring of special alloy steel is automatically traversed between side plates to vary oil delivery.

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Presses
Machine Tools
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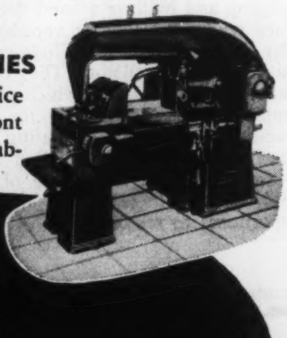
RACINE pumps will simplify your circuits. By-pass and relief valves with the accompanying extra piping are eliminated. Since RACINE pumps by-pass no oil, heating is reduced. Horsepower is saved. Quieter operation results. These features reduce installation cost and operating expense.

Let Racine hydraulic engineers review your applications. This service is available without cost or obligation. Write today, ask for catalog P-10-C. RACINE TOOL AND MACHINE COMPANY, 1773 State Street, Racine, Wisconsin.

RACINE *Hydraulic* METAL CUTTING MACHINES

A complete line in capacities 6" x 6" to 20" x 20" — in all price ranges. Features are simple. One lever control — open front design — progressive feed for cutting any metal from light tubing to tough tool steels. Write for Catalog No. 12.



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10 TON CYLINDER
6 TON CYLINDER
40 TON CYLINDER
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Job File No. 1949

MALLEABLE NUT PRODUCTION

Fully Automatic

CONTROLLED BY **T-J CYLINDERS**

All moving parts are controlled hydraulically by T-J Cylinders—on this Malleable Nut Production Machine designed and built by Roy Hays & Associates, Rockford, Ill., for the Wagner Malleable Products Co., Decatur, Ill.

It's *fully automatic*—the operator only places nuts in stations. Nine T-J Cylinders, 40 ton to ½ ton, help complete the job of cutting off sprue, sizing, boring, facing, chamfering and threading 2,500-¾ std. pipe thread nuts per hour.

For your tough jobs of power movement—pushing, pulling or lifting—*save labor, speed production* and *cut costs* with T-J Air and Hydraulic Cylinders! Many standard sizes and styles . . . both cushioned and non-cushioned types . . . 100 lb. or 50,000 lb. Precision-built for long-life dependability. Write for latest catalogs. The Tomkins-Johnson Co., Jackson, Michigan.

FOR POWER MOVEMENT IN ANY DIRECTION

100 LB. or 50,000 LB.

32 YEARS EXPERIENCE

T-J

TOMKINS-JOHNSON

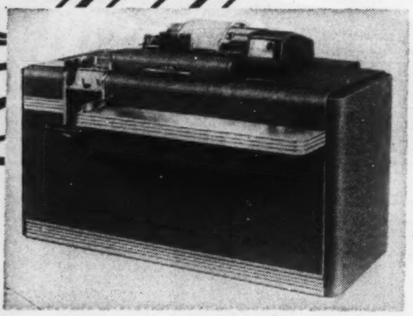
RIVITORS AIR AND HYDRAULIC CYLINDERS CUTTERS CLINCHORS

3 of your commonest assembly problems SOLVED by this one unique screw design

WHY?

It's exclusive with BRISTOL

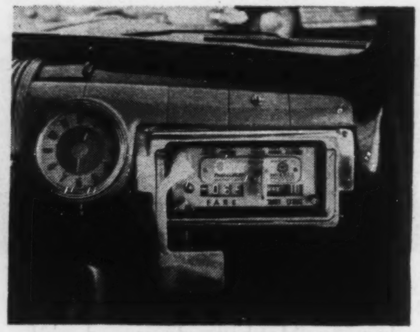
It's *exclusive* with Bristol—the socket design that uses the multiple-spline principle—best for transmitting torque. All the wrenching force is directed into rotary motion. Tighter sets with small sizes without damaging screw . . . quicker fastening . . . greater holding power . . . easier take-apart and reassembly.



COMPACT?

Then Buy BRISTOL'S Socket Screws

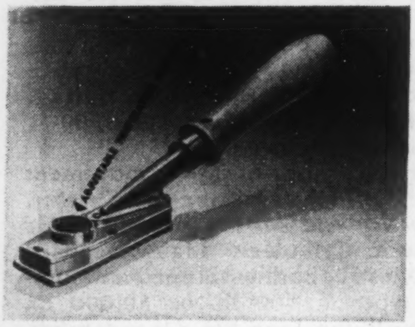
As you can imagine, there are hundreds of parts in every IBM computing machine. Because BRISTOL MULTIPLE-SPLINE SOCKET SET SCREWS have greater holding power . . . permit the use of smaller sizes for a more compact design of machine parts, IBM uses hundreds in each Electric Punched Card Accounting Machine.



SHAKE?

Then Buy BRISTOL'S Socket Screws

45 screws are needed to assemble a taxi meter. You know what a rough ride *that* gets. Ohmer Corporation, Dayton, Ohio, subsidiary of Rockwell Manufacturing Company—world's largest manufacturer of taxi meters—uses BRISTOL MULTIPLE-SPLINE SOCKET SET SCREWS because they set up tighter. *Result:* fare registers rarely get out of commission.



DISASSEMBLE?

Then Buy BRISTOL'S Socket Screws

A cellophane sealer made by Wells Mfg. Co. has a heat regulating device a part of which must be easily removable. This company selected BRISTOL MULTIPLE-SPLINE SOCKET SET SCREWS because the tight set is easily broken by a flick of a wrench. Faster repair work. No spoiled screws.

Send for Free Sample

and bulletin, addressing THE BRISTOL COMPANY, Mill Supply Division 122 Bristol Road, Waterbury 91, Conn.

Multiple-Spline and Hex Socket Screws . . . Cap and Set

BRISTOL'S

SOCKET SCREWS

Only BRISTOL gives you the right Socket Screw for every application

Using a "squared circle" to reduce sealing costs

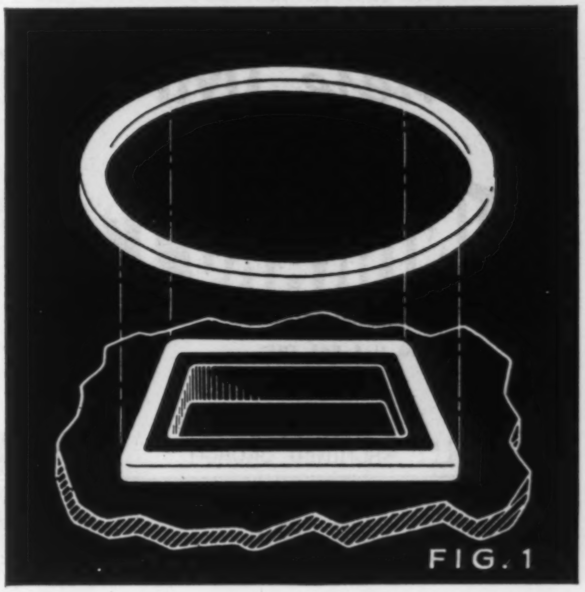


FIG. 1

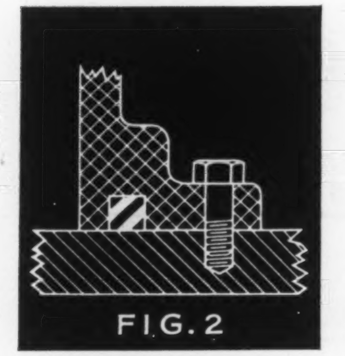


FIG. 2

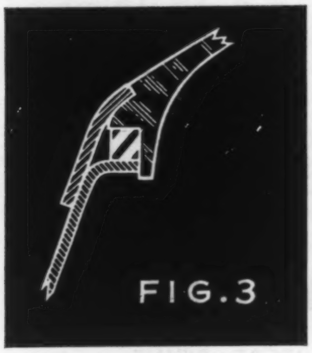


FIG. 3

The "squared circle" shown in figure 1 illustrates how circular lathe-cut gaskets can be used to seal non-circular flanges.

A circular gasket whose inner circumference equals the outer perimeter of the boss will distort to fit as shown. Because these gaskets are automatically lathe-cut from tubes of stock, virtually waste-free, they often cost less than die-cut parts.

For many such applications, Armstrong's Cork-and-Rubber Compositions provide effective, low-cost seals. They offer a range of compressibilities and solvent resistances for varied sealing jobs. And by permitting the use of smaller machined flanges—or even stamped or spun flanges, cork-and-rubber may reduce fabricating costs.

To utilize the "squared circle" principle, some means must be provided to position the gasket during assembly. While flanges must sometimes be altered to do this, it is often possible to use existing designs.

In figure 1, for example, the boss, previously used to insure accurate compression of the die-cut gasket, positions the lathe-cut gasket during assembly. To seal the heavy cover plate against oil, a firm cork-and-rubber composition is used.

Again in figure 2, the recessed channel in a die-cast fuel pump housing permits accurate positioning of the lathe-cut gasket. Because truly compressible Armstrong's Cork-and-Rubber does not extrude under pressure, the flanges mate perfectly.

The elliptical signal lamp lens shown in figure 3 holds the gasket in place. Here a soft cork-and-rubber composition is used to cushion the lens and provide a weatherproof seal on the stamped metal flange.

We urge you to discuss your applications with an Armstrong representative. Methods and materials he may suggest may help save production time and help reduce costs.

Send for this Gasket Handbook

You'll find useful application and specification data in the new, enlarged 24-page booklet, "Armstrong's Gasket and Sealing Materials." It contains up-to-date data on synthetic rubber, cork-and-synthetic-rubber, cork composition, and fiber sheet sealing materials.

This booklet includes ten technical discussions of the factors influencing modern gasket and joint design. It also suggests methods of putting Armstrong's stock materials to specialized uses in such fields as radio, electrical, automotive, petroleum, and transportation industries. Also included are typical applications and current government specifications.

For your free copy, fill in coupon at right and mail today.

ARMSTRONG'S
GASKET AND SEALING
MATERIALS

ARMSTRONG CORK CO.
Gaskets and Packings Dept.
5108 Arch Street, Lancaster, Pa.

Please send me at once a copy of the new 24-page booklet, "Armstrong's Gasket and Sealing Materials."

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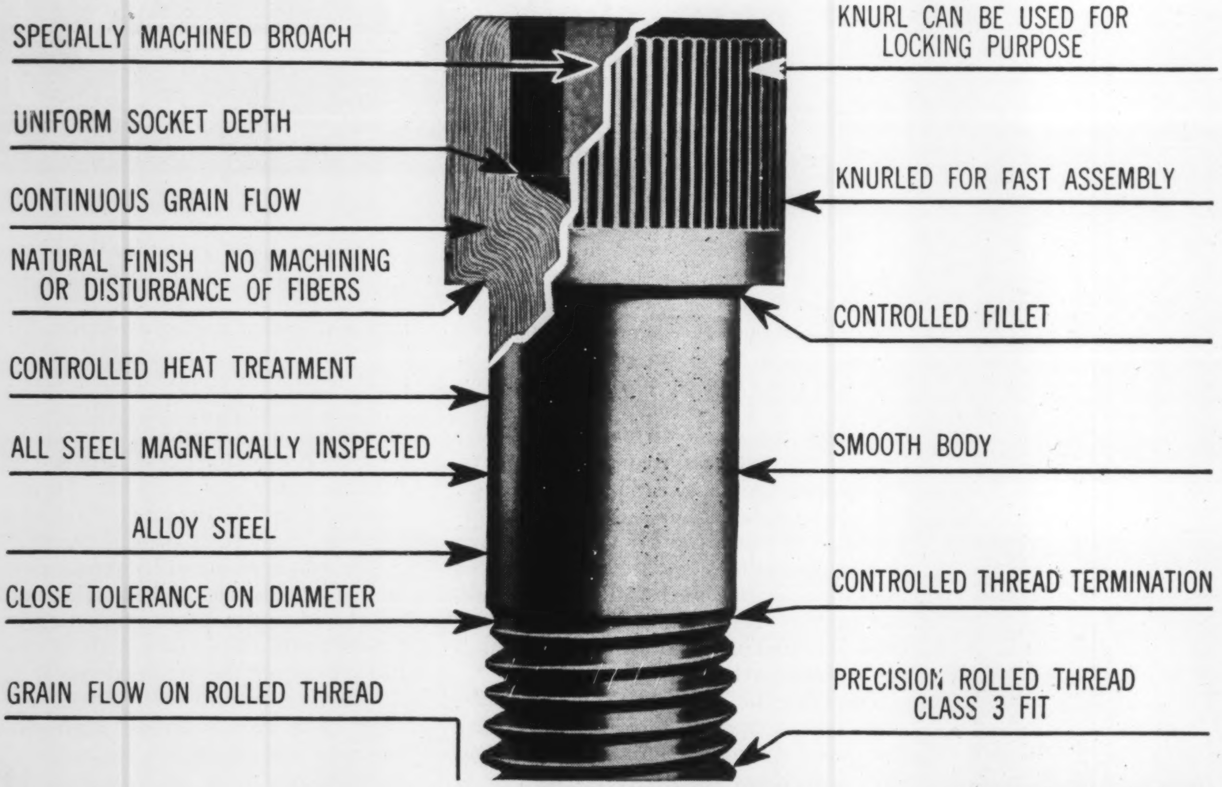
ARMSTRONG'S
GASKETS • PACKINGS • SEALS

These IMPORTANT FEATURES *of*

UNBRAKO KNURLED SOCKET HEAD CAP SCREWS

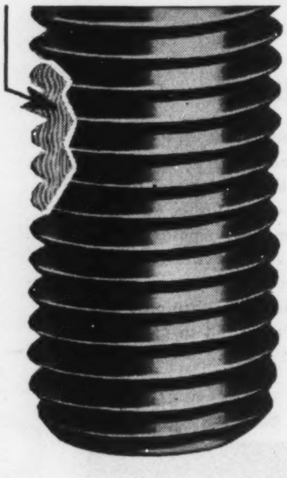
REG. U. S. PAT. OFF.


SPECIALLY MACHINED BROACH
UNIFORM SOCKET DEPTH
CONTINUOUS GRAIN FLOW
NATURAL FINISH NO MACHINING OR DISTURBANCE OF FIBERS
CONTROLLED HEAT TREATMENT
ALL STEEL MAGNETICALLY INSPECTED
ALLOY STEEL
CLOSE TOLERANCE ON DIAMETER
GRAIN FLOW ON ROLLED THREAD
KNURL CAN BE USED FOR LOCKING PURPOSE
KNURLED FOR FAST ASSEMBLY
CONTROLLED FILLET
SMOOTH BODY
CONTROLLED THREAD TERMINATION
PRECISION ROLLED THREAD CLASS 3 FIT

Give you these OUTSTANDING ADVANTAGES

STRENGTH, TOUGHNESS, RELIABILITY . . . the result of constant testing, inspection and quality control.

KNURLED HEAD FOR EASY ASSEMBLY . . . the knurled head provides a slip- and fumble-proof grip, even for the most oily fingers, therefore, the screw can be screwed-in faster and farther before it becomes necessary to use a wrench.



EASY START THREAD POINT . . . specially designed to assure fast, easy thread start.

INTERNAL WRENCHING . . . to promote Compact Designs which save space, material, weight and costs. Write for your copy of the "Unbrako" Catalog.

"Unbrako" Products are sold entirely through Industrial distributors.

We also make the famous "Unbrako" Socket Set Screw with the "Self-Locking" Knurled Cup Point, and the "Unbrako" Socket Set Screw with the "Self-Locking" Knurled Threads.

OVER 46 YEARS IN BUSINESS

Knurling of Socket Screws originated with "Unbrako" in 1934.

SPS

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Houghton...

the packing supplier that prepared the first authentic handbooks on leather and synthetic rubber packings, is now

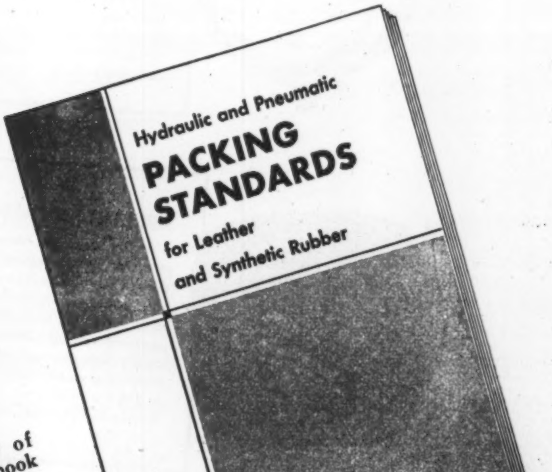
first to set up "specs" for packing standards!

Industry expressed a desire for packing standardization, as between types of packings, dash numbers, uniform clearances and tolerances. Number of sizes should be reduced also, it was stated at the Joint Industry Conference meetings in Detroit.

Houghton was ready and willing to cooperate. Even better, our engineers showed them how it could be done, and then led the way for other packing suppliers by setting up specifications which will be generally followed.

We then prepared the handbook shown here, as a supplement to our authoritative reference books on leather and synthetic rubber packings. This book should be in the hands of every designer of hydraulic equipment, and packing maintenance man.

Here is another indication of Houghton's leadership in hydraulic and pneumatic packings. The engineering service on individual installations, the high quality and workmanship built into the packings themselves, and the ability to plan and prepare such cooperative projects for the aid of industry — all these are reasons why you should consult Houghton when you need packings.



For free copy of this new handbook write on your firm's letterhead to Hydraulic & Transmission Dept., E. F. Houghton & Co., 303 W. Lehigh Ave., Phila. 33, Pa.

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CHICAGO • SAN FRANCISCO • DETROIT
Vim Leather & Vix-Syn Synthetic Rubber Packings

More OEM's* Specify US Gauge Than Any Other Make!

*Original Equipment Manufacturers

. . . Because USG Assures More Value

Throughout industry, the story is the same from year to year. Original equipment manufacturers (OEM's) demand substantial gauge value . . . accuracy, durability, and quality at economy prices . . . and 6 out of 10 specify US Gauges.

They know that US Instruments give more service, more accuracy, more *value* for the money. They know USG can supply all their needs—from highly specialized instruments measuring as low as 1" of mercury absolute, to standard type gauges measuring from 30" vacuum to 100,000 pounds pressure per square inch. And they know that for more than 40 years US Gauges have been the standard of dependability. So more original equipment manufacturers specify US Gauges than any other make.

Next time you order gauges, follow the lead of these satisfied users . . . buy US Gauges. For more information about US Gauge write today. United States Gauge, Division of American Machine and Metals, Inc., Sellersville, Penna.

US GAUGES—BETTER INSIDE . . . BETTER OUTSIDE . . . BETTER ON YOUR PRODUCT

USG

UNITED STATES GAUGE

10
20
30
40
50
60
70
80
90
100
SUPERGAUGE

SUPERGAUGE FIG. 1600

For heavy-duty service where a gauge of quality and high accuracy is required. Stainless steel movement with deep bushed bearings. Phosphor bronze, beryllium copper or welded stainless steel bourdon tube in iron or phenolic cases. Lower or back connections. Ranges: 0 to 30" vacuum, 15 to 20,000 lbs. p.s.i.

5000
10000
15000
20000
25000
30000
35000
40000
45000
50000
SUPERGAUGE

HIGH PRESSURE SOLID FRONT GAUGES

Designed for testing high pressure gases and liquids these gauges are built to the highest possible standard. Solid wall, cast integral with case, separates the tube and movement section from observer. Bourdon tubes of specially selected beryllium copper or stainless steel are threaded at both ends. Has deep bushed stainless steel movement of high ratio. Cast brass case and ring. Ranges: 100 to 100,000 lbs. pressure.

20
2
4
6
8
10
12
14
16
18

ABSOLUTE PRESSURE GAUGE

A highly accurate, dependable instrument for measuring absolute pressures. Gauge is seal case type designed to indicate pressure or vacuum admitted to interior actuating the seasoned beryllium copper diaphragm. Black molded phenolic case is corrosion resistant, suitable for use in highly contaminated atmospheres. Dial is 2¾" in diameter. Ranges: 20 millimeters to 100 inches of mercury.

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COMPANY ____________________

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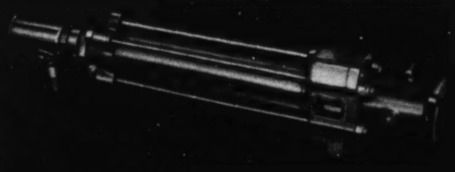
Swinging the Big Sticks with

VICKERS Hydraulic POWER STEERING

GERLINGER MATERIAL CARRIER

Another Cost-Cutting Application of VICKERS HYDRAULICS

VICKERS
HYDRAULIC POWER STEERING
is Effortless, Positive, Shockless



Vickers Hydraulic Steering Booster with Integral Overload Relief Valve. Bulletin 47-30a.

Vickers Balanced Vane Type Pump is Engine Driven. Bulletins 36-12 and 49-52.

Vickers Hydraulic Power Steering makes it easier and cheaper to handle logs and large piles of lumber with the Gerlinger Material Carrier. Four Wheel Steering is effortless in spite of very heavy front wheel loading. The quick, easy maneuverability speeds operation . . . substantially lowers materials handling costs.

Not only is Vickers Hydraulic Power Steering effortless and safe, it also avoids load on the conventional steering gear. Steering force reaction is absorbed by the vehicle frame . . . road shock does not reach the steering gear.

Vickers Hydraulic Power Steering is saving money for the users of carriers, trucks, road machinery and other mobile equipment . . . not only by speeding operation, but also by reducing driver fatigue. For detailed information, ask for Bulletin 47-30a.

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Plymetl will help you increase the performance and salability of your products

Haskelite* Plymetl unites plywood's great rigid strength and light weight with the tensile strength of sheet metal. The many users of Haskelite Plymetl find it a material with a flat, smooth, ripple free surface that adds new eye appeal to the products they use it on.

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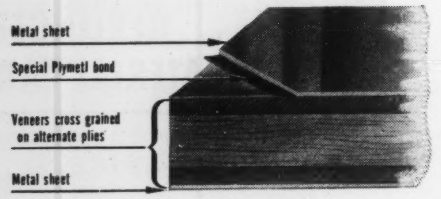
If you wish to add a new high standard of eye appeal and reputation building performance to your products — specify Haskelite Plymetl. Write for your free copy of "Plymetl—a material of opportunities."

*T.M. Reg.

CUTS WEIGHT AND BULK — SIMPLIFIES FABRICATION

PLYMETL

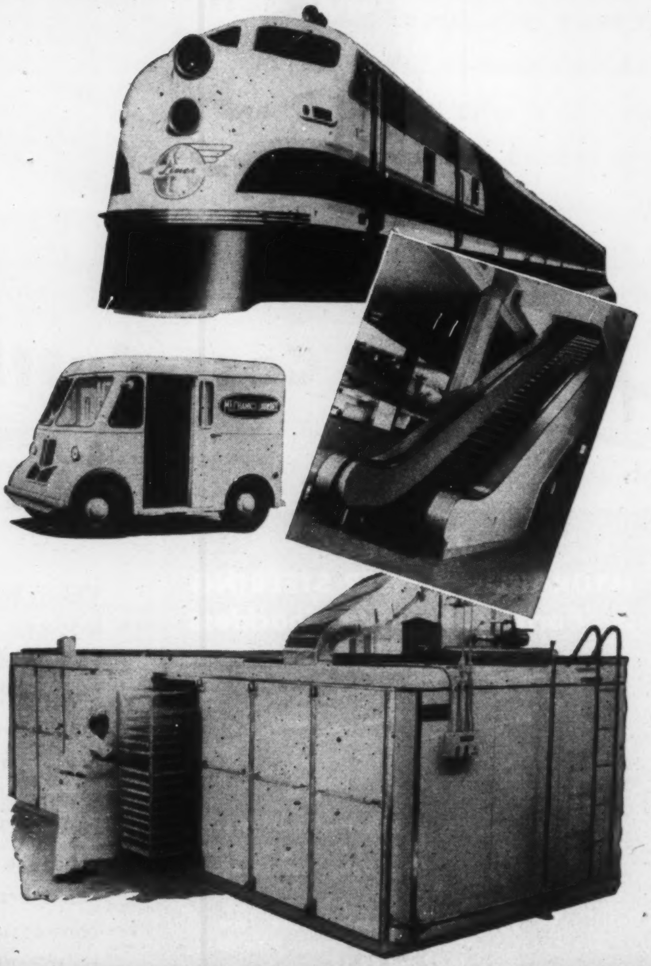


Plymetl consists of light gauge metal sheets permanently bonded to one or both sides of a plywood panel. Sheets of zinc coated steel, aluminum or other metals may be used. One type of material may be bonded to one side of the panel, and another type to the other if desired. Panels of Haskelite Plymetl are easily fabricated with simple metal or wood working tools. It may be obtained in a range of thicknesses and sizes to fit specific requirements.

TYPICAL USES

Diesel locomotive side panels, escalator panels, table tops, truck trailer side panels, delivery truck bodies, railway passenger car interiors, bakery proof boxes, bread coolers, air conditioning equipment, low temperature drying ovens, etc.

"ESCALATOR"—T. M. Reg. by Otis Elevator Company



HASKELITE T.M. Reg.

structural materials for men who build better

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Canada: Railway & Power Engineering Corp., Ltd.

wherever connectors must move

Connection between air compresser and ping chamber is made through this ¾″ I. D. seamless bronze American Flexible Connector.

This ¾″ I. D. seamless bronze American Flexible Connector on a C. R. & L. Motorbus carries air from compressor to reservoir.

Photos courtesy Connecticut Railway & Lighting Lines.

Air-line piping for motorbus brakes and doors takes constant punishment from movement and vibration. In the piping illustrated here, American Seamless Flexible Metal Tubing provides safe, *flexible* connectors that can bend freely as the piping moves and vibrates.

There is a type and size for carrying fluids, steam, semisolids, or gases. If yours is a special problem, American engineers offer you their long years of varied experience in connector applications.

For complete information on American Flexible Metal Hose and Tubing, write for literature. Address your inquiry to The American Brass Company, American Metal Hose Branch, Waterbury 88, Connecticut. In Canada, The Canadian Fairbanks-Morse Co., Ltd.

49292

ANACONDA from mine to consumer

American

flexible metal hose and tubing

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MOTOR EXCHANGE SERVICE

For Westinghouse
single-phase and three-phase
1 to 20 hp
frame 203 to 326 a-c motors

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The Broadest Exchange Plan!

Since February, 1949, Life-Line motors have offered you the broadest exchange plan in industry. All 1 to 20-hp, single-phase and three-phase a-c motors in frame 203 to 326 are included. No other manufacturer of motors—large or small—provides exchange service that compares in scope to this new Life-Line Motor Exchange Service.

120 Westinghouse exchange points assure you rush motor replacement service anywhere in the United States. Replacement motors, covered by this plan, are in stock, ready to be speeded to you at any time.

And what's more, if a motor fails during warranty period, it may be exchanged *free* for a motor of identical rating. The *exchange price,* beyond warranty, *is not dependent on the time in service . . . one year, five years or ten years.*

This service is one more advantage you get with Life-Line motors. Add this to all-steel construction . . . pre-lubricated bearings . . . an indicated savings of $750 per year per 100 motors . . . and you'll see why Life-Line has gained leading acceptance in the motor industry.

Complete details on the Life-Line Exchange Service—lists of exchange points and motor ratings covered—are given in the new booklet SM-5243. Get your copy today from your nearby Westinghouse representative or write direct to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna. J-21533

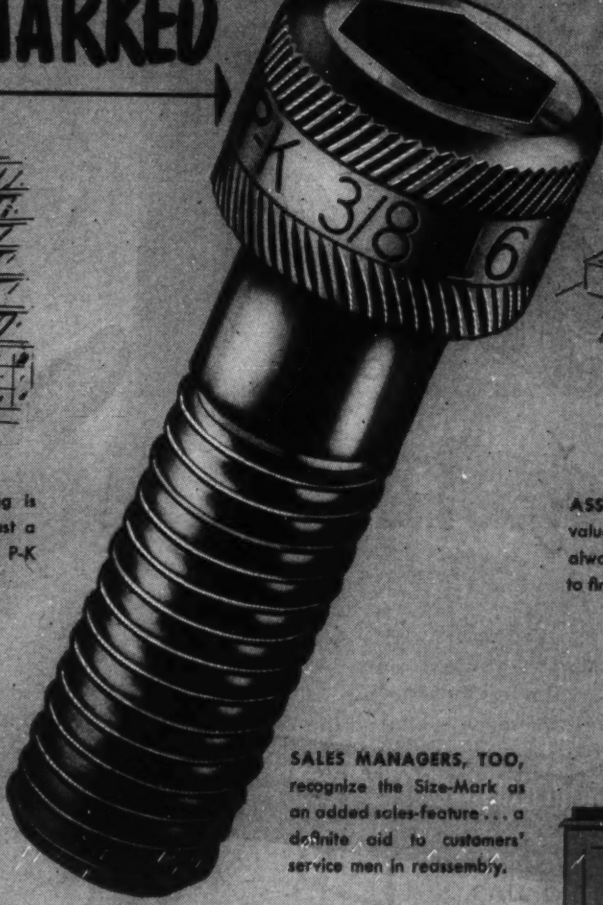
Westinghouse
Life-Line
Motors

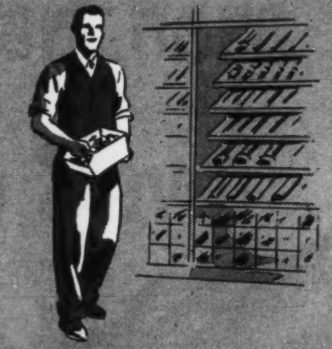
WESTINGHOUSE

Here's what they say about P-K®

SIZE-MARKED

Socket Head Cap Screws





TOOL CRIB BOSSES say sorting is made easier, speeded up . . . just a quick glance at the head of any P-K Cap Screw reveals its size.

ASSEMBLY LINE OPERATORS report valuable time saved because sizes are always issued correctly . . . no time out to find out — job moves faster.

SALES MANAGERS, TOO, recognize the Size-Mark as an added sales-feature . . . a definite aid to customers' service men in reassembly.

NEW HELP agree sizes can be learned faster . . . also, the Size-Mark protects them from errors.

Plus . . . GEAR GRIP* . . . it simplifies work!

Gear Grip on Size-Marked Socket Head Cap Screws is a further aid to fast work . . . prevents slipping even when fingers are oily.

ONLY PARKER-KALON OFFERS BOTH Size-Mark and Gear Grip in Socket Head Cap Screws. See how they save time and trouble all along the line.

SEND FOR SAMPLES. Discover for yourself why P-K Socket Screws can put your product out front, assembly-wise and sales-wise. Parker-Kalon Corporation, 200 Varick Street, New York 14, New York.

P-K Socket Screws are available for prompt delivery in every industrial area.

SEND FOR STOCK LIST NOW

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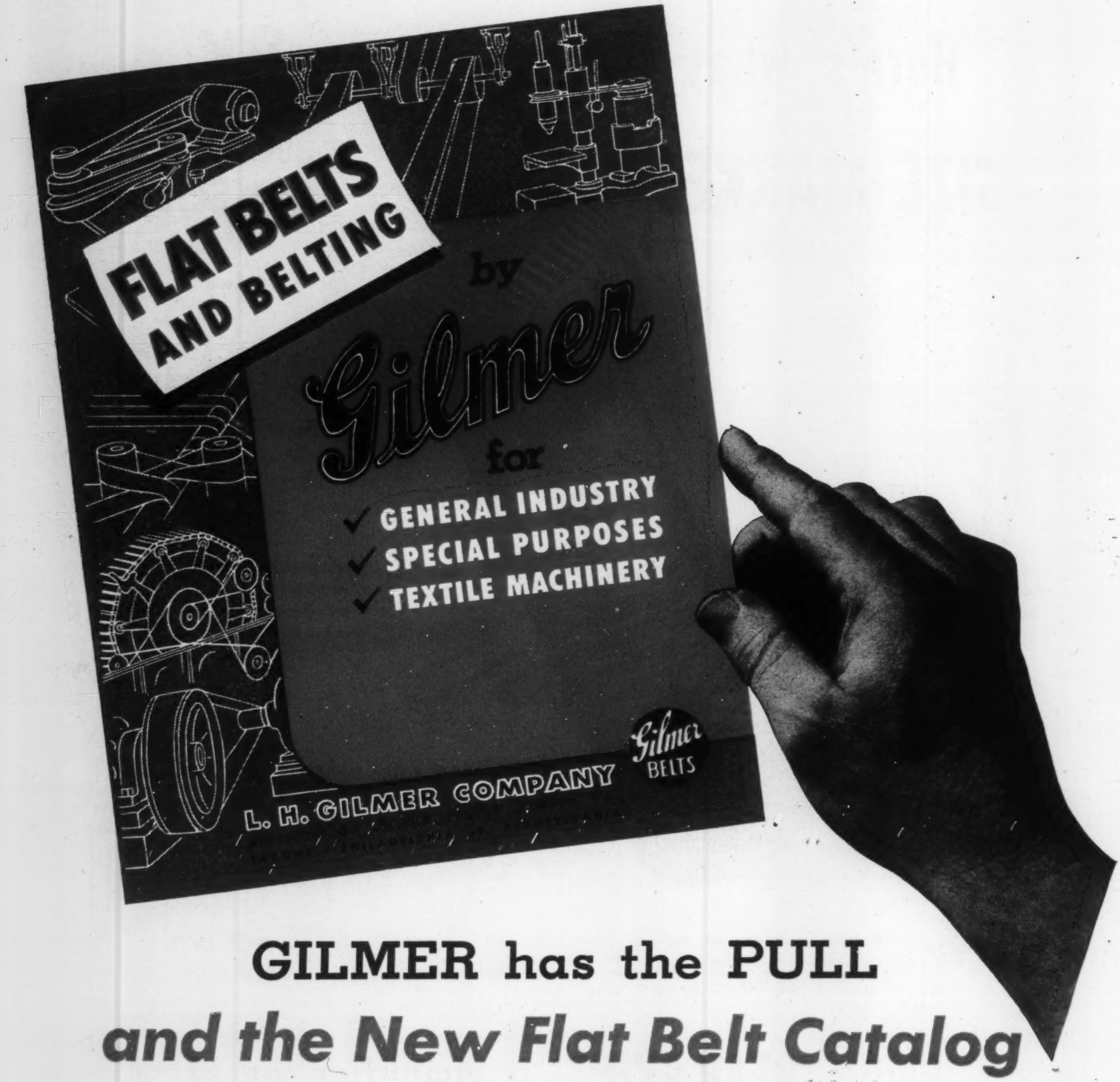
*U. S. DESIGN PAT. NO. 130,400 SOLD ONLY THROUGH ACCREDITED DISTRIBUTORS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Gilmer specializes in belts, including V-Belts and the amazing Gilmer "Timing" Belt that operates at zero slippage, opening up new possibilities in machine design.

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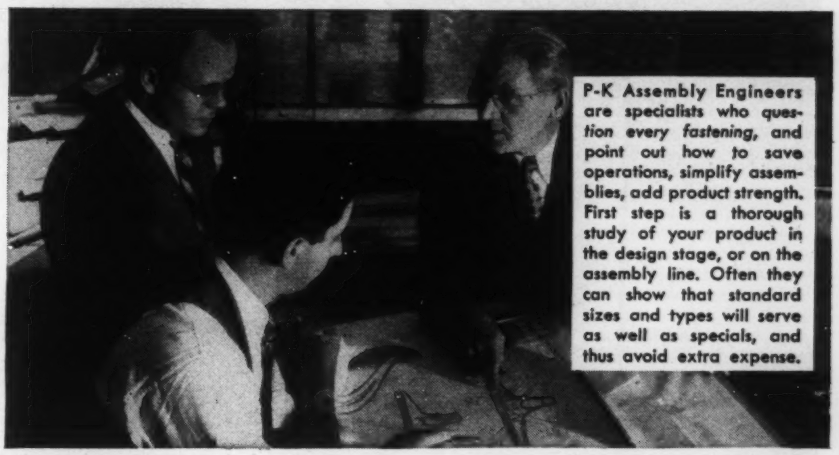
GILMER SPECIALIZES IN BELTS

P-K Assembly Engineering Service

helps you start here to Save



P-K Assembly Engineers are specialists who question every *fastening*, and point out how to save operations, simplify assemblies, add product strength. First step is a thorough study of your product in the design stage, or on the assembly line. Often they can show that standard sizes and types will serve as well as specials, and thus avoid extra expense.

up to 50% or MORE on Fastening Costs

When required, tests of recommended fastenings are made in Parker-Kalon's Engineering Service Laboratory.

All recommendations are combined in a complete report furnished as a guide for assembly operations.

Qualified by thirty-five years' experience, Parker-Kalon Assembly Engineers can sit in with designers and assembly supervisors and *show how* to adapt the simpler, operation-saving P-K method, how to cut out all needless fastening expense. That's one of many reasons why . . .

more FASTENING-WISE MANUFACTURERS CALL ON PARKER-KALON

Look at all these other advantages...

MORE Know-How—Parker-Kalon originated the Self-tapping Screw and has been the leader with new designs ever since.

MORE Types and Sizes—With a complete line of Self-tapping Screws for every metal and plastic assembly, P-K's advice is unbiased.

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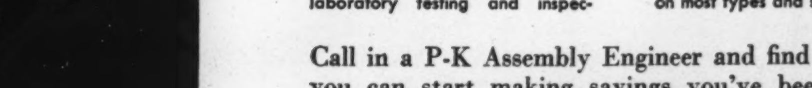
PROMPT DELIVERIES from stock on most types and sizes.

Call in a P-K Assembly Engineer and find out where you can start making savings you've been missing. If you prefer, mail assembly details for recommendations. Parker-Kalon Corporation, 200 Varick St., New York 14, N. Y.

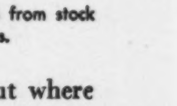
P-K® *The Original*

PARKER-KALON SELF-TAPPING SCREWS

FOR EVERY METAL AND PLASTIC ASSEMBLY



P-K Also Makes
Cold-forged



OTHER P-K PRODUCTS: Cold-Forged Socket Screws, Wing Nuts, Thumb Screws • Hardened Screwnails and Masonry Nails • Shur-Grip File and Solder Iron Handles • Metal Punches • Damper Regulators and Accessories

[illegible] on propeller shafts

[illegible] correctly protects its [illegible] speed, underwater [illegible] These fast-moving PT boats were able to operate under severe conditions without danger of shaft seal failure.

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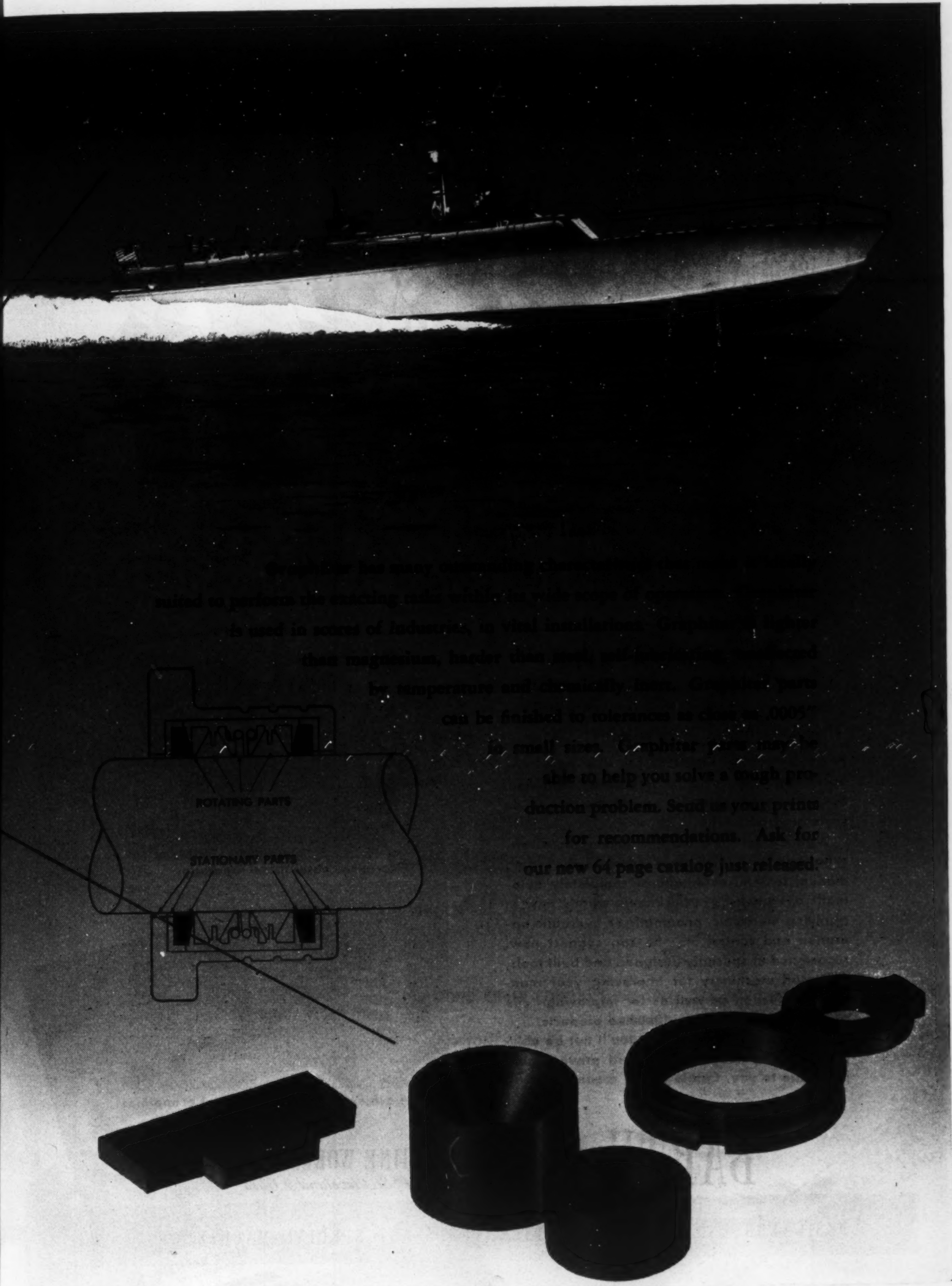

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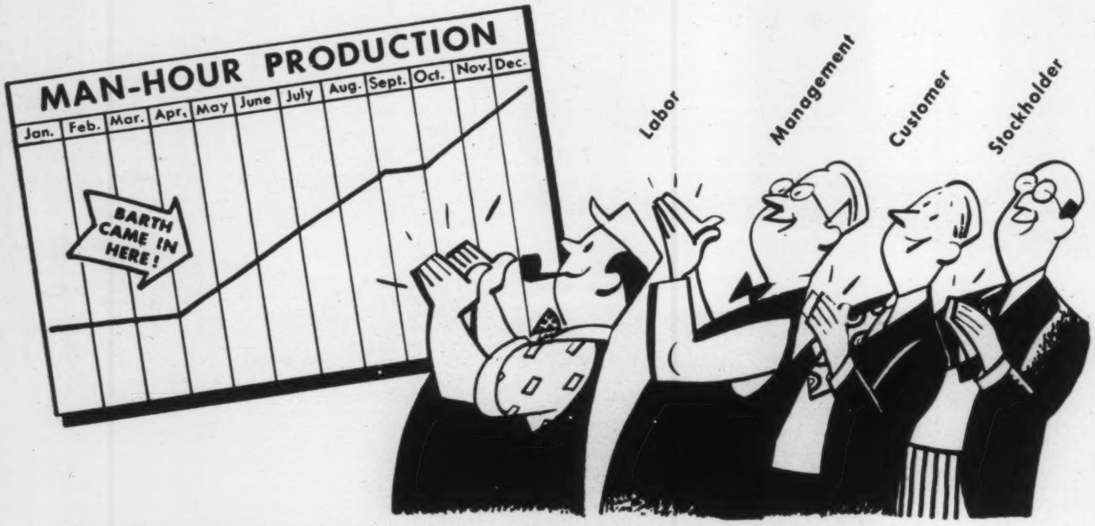

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when man-hour output is improved!

Competition can be met at a profit
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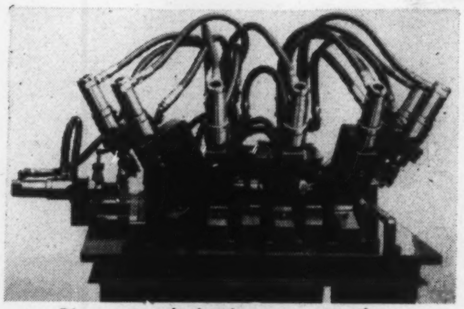
Stockholders' faith is justified

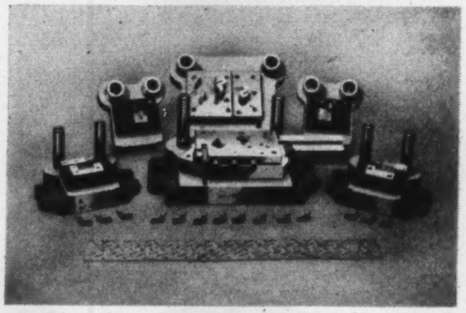
IN YOUR OWN BUSINESS, if you have any operations that could be improved, simplified, combined or stepped up, now is the time to do something about it!

Why not call in a Barth engineer for a consultation? He knows what's new in converting manual to semi-automatic or completely automatic operations . . . he knows what's new in applying electronic, pneumatic or hydraulic operation and control . . . he can suggest new, redesigned or specially designed and built tools, dies and machinery for improving your man-hour production as well as for improving "eye and buy" appeal of your finished products.

Ask for a consultation . . . you'll not be obligated in any way and it could prove highly profitable to you. Catalogue on request.



Pierces ten holes in one operation



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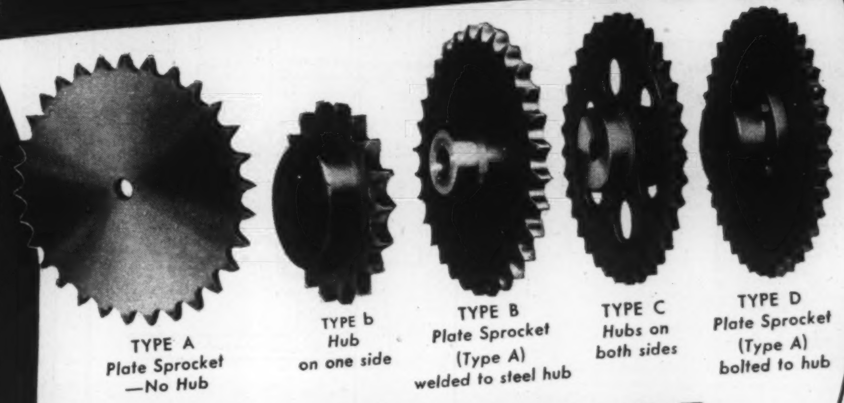
TYPE A
Plate Sprocket
—No Hub
TYPE b
Hub
on one side
TYPE B
Plate Sprocket
(Type A)
welded to steel hub
TYPE C
Hubs on
both sides
TYPE D
Plate Sprocket
(Type A)
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COMPLETE STOCK OF DIAMOND ROLLER CHAIN

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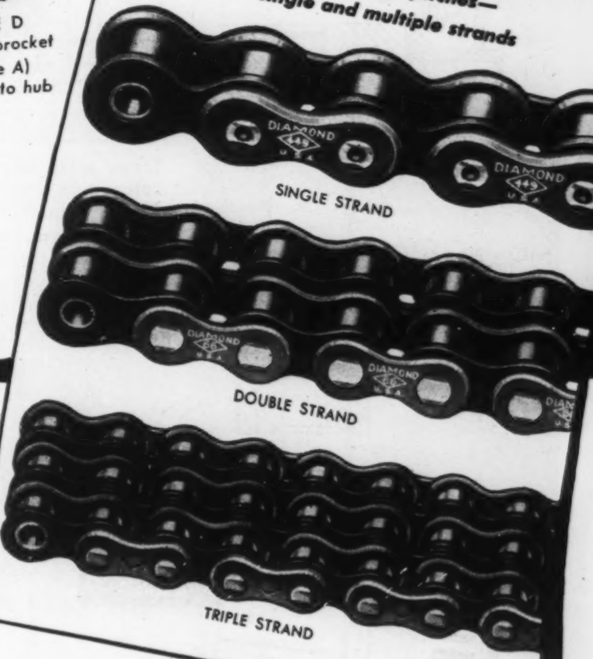
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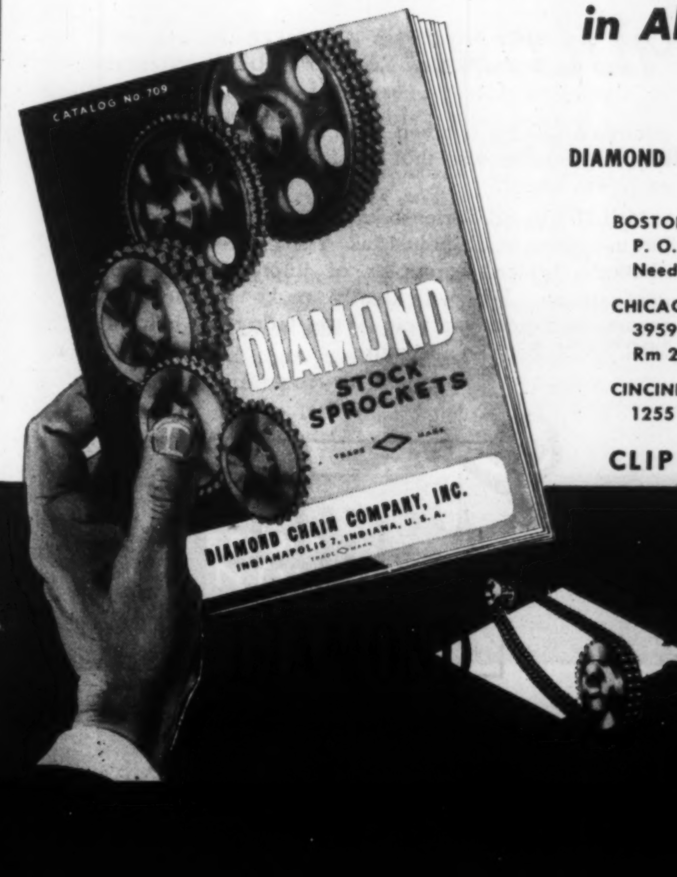
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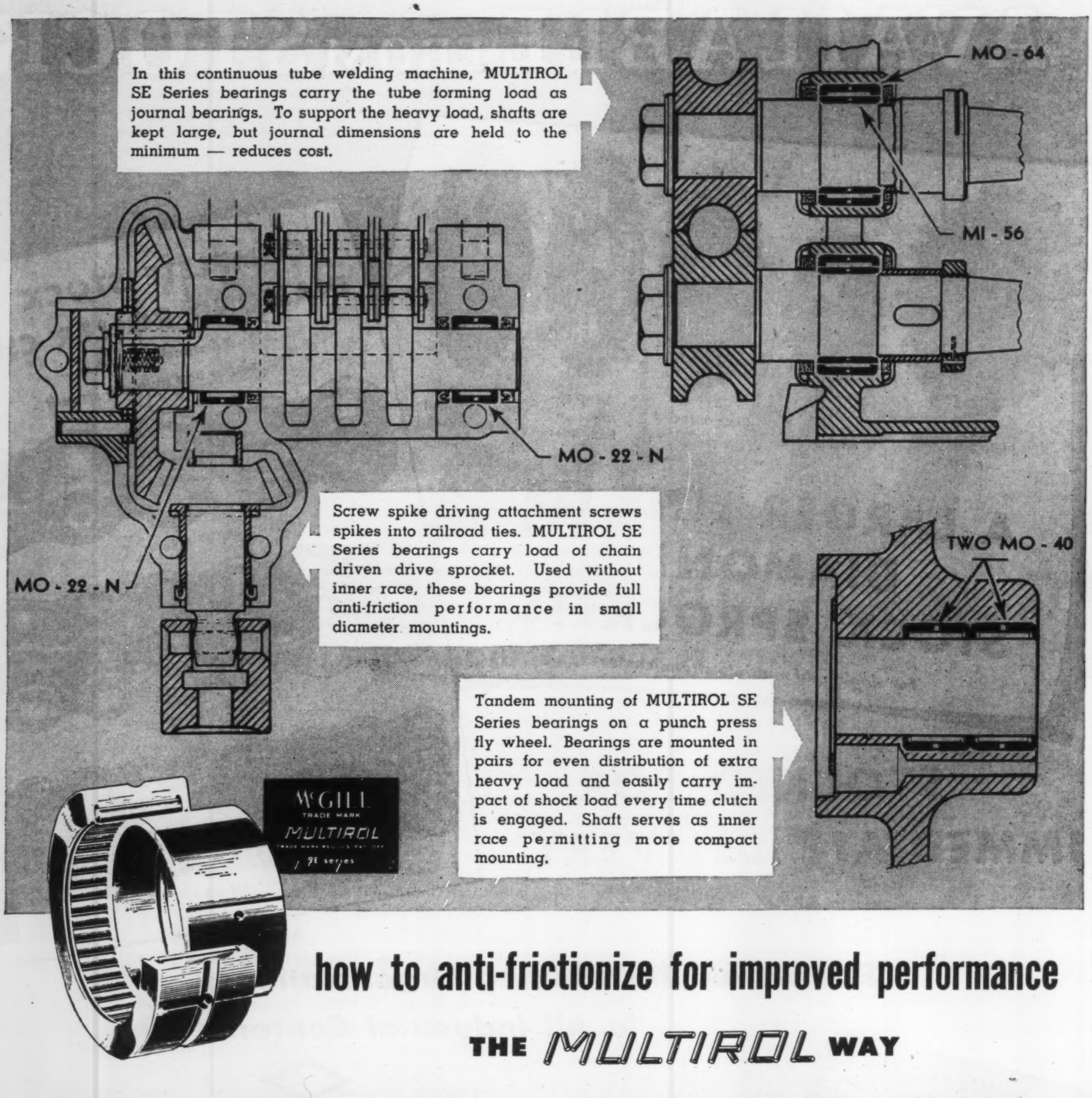

In this continuous tube welding machine, MULTIROL SE Series bearings carry the tube forming load as journal bearings. To support the heavy load, shafts are kept large, but journal dimensions are held to the minimum — reduces cost.

Screw spike driving attachment screws spikes into railroad ties. MULTIROL SE Series bearings carry load of chain driven drive sprocket. Used without inner race, these bearings provide full anti-friction performance in small diameter mountings.

Tandem mounting of MULTIROL SE Series bearings on a punch press fly wheel. Bearings are mounted in pairs for even distribution of extra heavy load and easily carry impact of shock load every time clutch is engaged. Shaft serves as inner race permitting more compact mounting.

how to anti-frictionize for improved performance

THE MULTIROL WAY

The efficiency of any machine can be raised when plain friction bushings are replaced with MULTIROL SE Series full type roller bearings. Speeds are easily increased and accuracy improved over a longer expected bearing life.

The MULTIROL Way requires less maintenance because lubrication can be provided through either the shaft or housing — oil holes and channels in both outer and inner — no need for constant oiling — no danger of dry journals when lubrication is temporarily neglected.

Costs less too. Ordinarily large housings can be reduced to accommodate the MULTIROL Bearing minimum OD for a given shaft size and load capacity. Remember also that eliminating friction saves on power imput.

MULTIROL SE Series bearings are anti-frictionizing machines in all industries. The above drawings illustrate typical examples of improved bearing applications. We will gladly make engineering recommendations for you. Write today for helpful MULTIROL Bearing literature.

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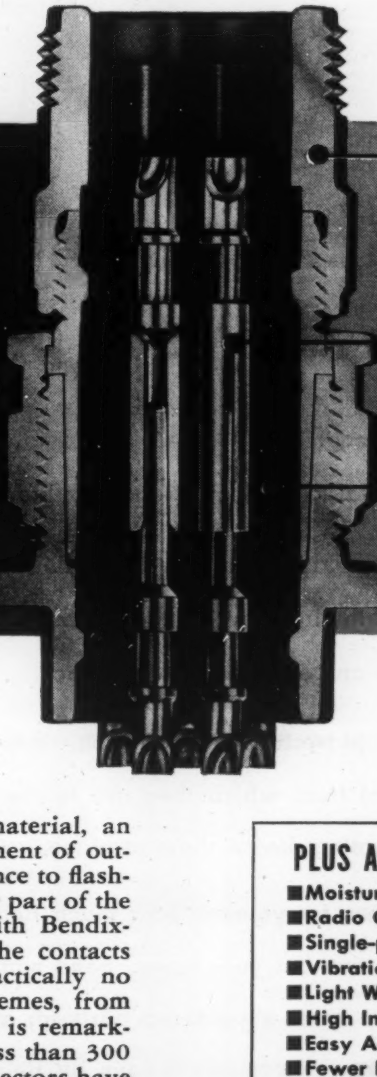
ONLY BENDIX-SCINTILLA

ELECTRICAL CONNECTORS

offer you SCINFLEX★ SUPERIORITY!



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High strength aluminum alloy . . . High resistance to corrosion . . . with surface finish.

CONTACTS

High current capacity . . . Low voltage drop . . . No additional solder required.

SCINFLEX★ ONE-PIECE INSERT

High dielectric strength . . . High insulation resistance.

★**SCINFLEX** dielectric material is a new development that assures unequalled insert performance. It is available only in Bendix-Scintilla Electrical Connectors.

The use of **SCINFLEX** dielectric material, an exclusive Bendix-Scintilla development of outstanding stability, increases resistance to flash-over and creepage. And this is only part of the many new advantages you get with Bendix-Scintilla* Electrical Connectors. The contacts carry maximum currents with practically no voltage drop. In temperature extremes, from −67° F. to +300° F., performance is remarkable. Dielectric strength is never less than 300 volts per mil. Bendix-Scintilla Connectors have fewer parts than any other connector on the market—and that means lower maintenance costs and better performance.

*TRADEMARK

PLUS ALL THESE OTHER FEATURES

- Moisture-proof, Pressure tight
- Radio Quiet
- Single-piece Inserts
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- High Insulation Resistance
- Easy Assembly and Disassembly
- Fewer Parts than any other Connector
- No additional solder required

Write our Sales Department for detailed information.

BENDIX
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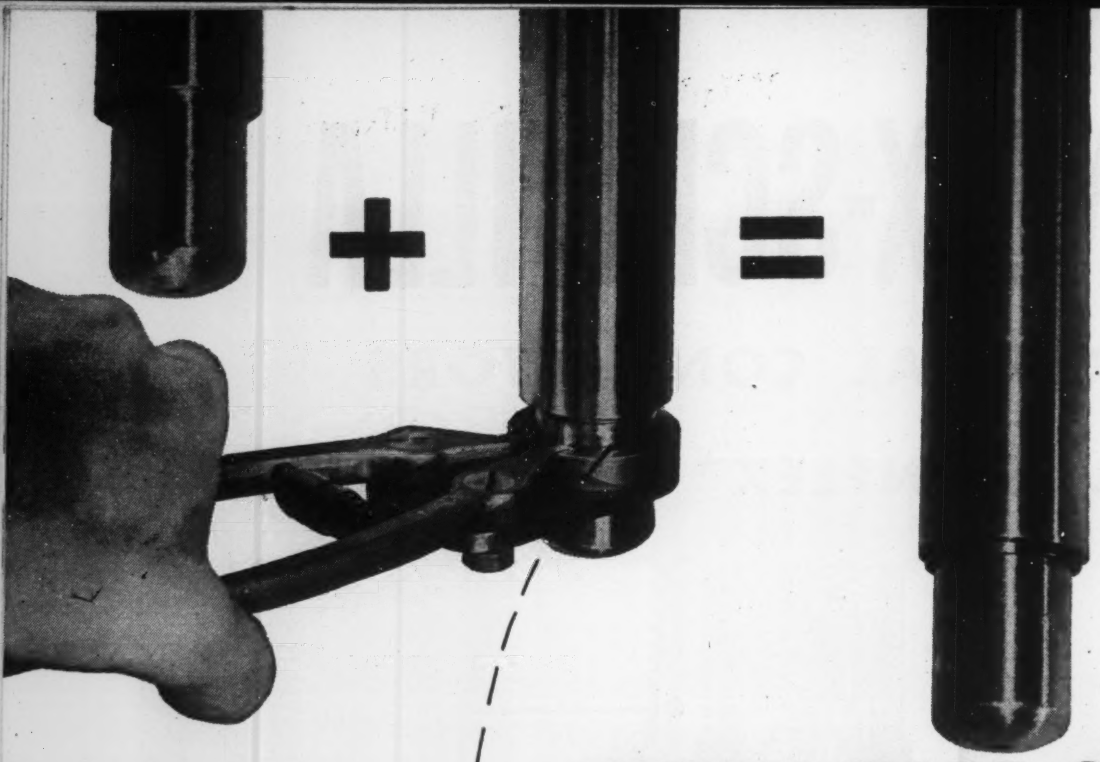

READY-MADE SHOULDERS

to cut your production costs

No longer is it necessary to tediously machine away pounds of metal to produce strong shoulders on shafts or in counterbores.

With ready-made shoulders—Reliance Snap Rings—you merely machine a groove at the proper place on the shaft or in the bore and snap the ring in place.

The powerful spring tension, developed in the cold drawn steel from which they are formed, plus controlled heat treating, keeps them in place, even under heavy thrust loads.

See for yourself how much Reliance Snap Rings can cut your costs. Send samples or prints of your shouldered parts for study and recommendations by Reliance engineers.

Reliance Spring Lock Washers automatically keep bolts, nuts, screws tight under constant tension—compensate for wear and developed looseness. All sizes—many types. Write for Spring Lock Washer folder.

Eaton Springtites—Powerful Reliance Spring Lock Washers of proper size and type, permanently pre-assembled on bolts or screws—speed assembles . . . cut costs. Write for Eaton Springtite folder.

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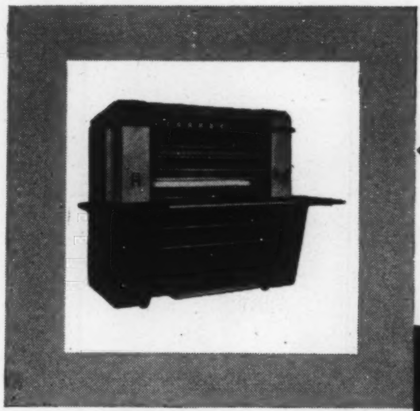

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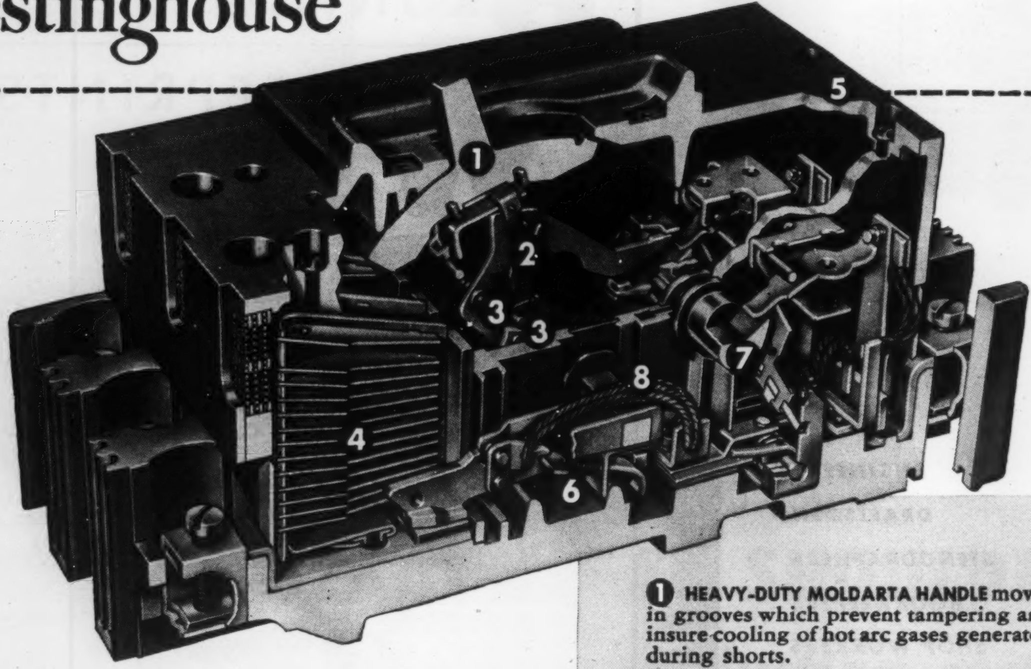
YOU CAN BE **SURE**.. IF IT'S

Westinghouse



Count 'em...

Ten Vital Features that Save Space, Man-Hours and Dollars

You will save space, man-hours and dollars with Westinghouse Type AB Breakers—breakers that point the way to modern circuit protection by completely eliminating fuse replacement. This characteristic slashes costs and man-hours over a period of time. But that's only the beginning. Your system gets long-life, never-failing protection, too . . . the kind of protection that allows you to take the safety of your equipment for granted.

And talk about saving space—AB Breakers can be installed side by side with complete safety, operate in any position, and are completely protected against tampering.

Get complete information on today's *modern* breaker—the safe, sure, dependable AB. Call your Westinghouse representative, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

J-30004

① **HEAVY-DUTY MOLDARTA HANDLE** moves in grooves which prevent tampering and insure cooling of hot arc gases generated during shorts.

② **OPERATING TOGGLE MECHANISM** is trip-free in all positions and is the quick-make and quick-break type.

③ **ALL BEARING SURFACES** are of dissimilar metals to prevent sticking due to possible corrosion, and to prevent bearing wear.

④ **"DE-ION"** principle of arc extinction with latest improved plate structure.

⑤ **DEAD FRONT CONSTRUCTION** protects operator. Mechanism is entirely enclosed in hot-molded, phenolic material (Moldarta).

⑥ **REVOLUTIONARY CONTACT ARM** design gives increased pressure with wear; hence less watt loss.

⑦ **COMMON TRIP.** Multi-pole units have insulated common-trip bar that opens all poles when an overload occurs on any one.

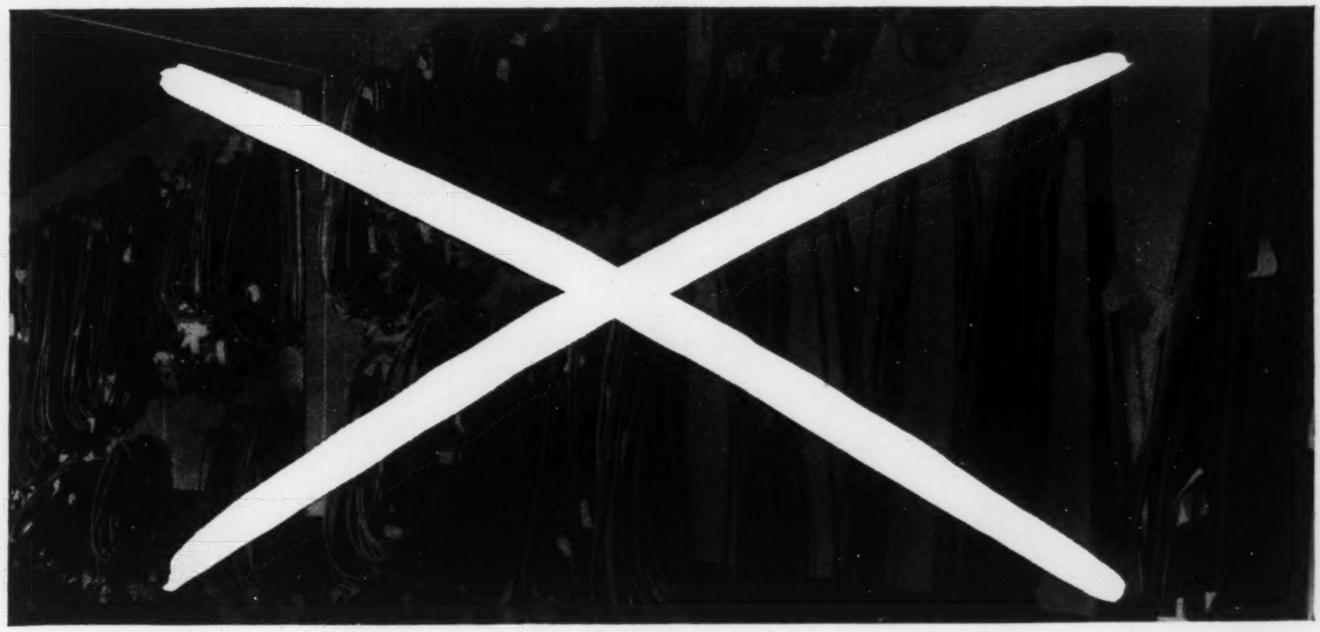
⑧ **INTER-POLE BARRIERS** and insulating couplings insure protection against high surge voltages.

FACTORY-SEALED. Breaker is sealed to prevent unauthorized changing of calibration.

CORROSION RESISTANT. All parts are especially treated or selected to resist corrosion.

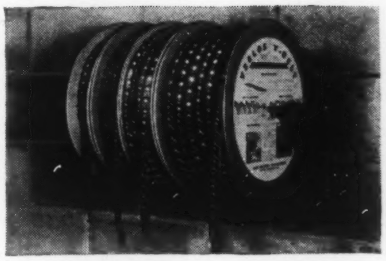
Westinghouse

AB BREAKERS

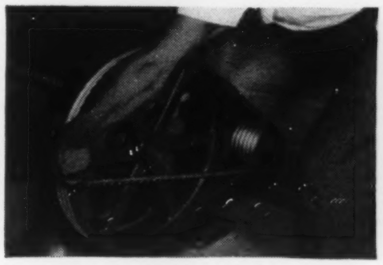


Here's how to cut your v-belt costs

You can replace up to 316 sizes of endless v-belts with just 4 reels of Veelos



From these four reels of Veelos you can make up 316 sizes of O, A, B and C section endless v-belts.



Any length belt can be coupled for quick installation on any drive in a few minutes.

Machine downtime is practically eliminated. Sliding or pivoted motor bases are not needed.

MAYBE you need belts of only one or two widths—but many different lengths—to keep all your drives producing. Then one or two reels of Veelos will give you a *complete* v-belt inventory.

You don't need to tie-up working capital in a heavy v-belt stock . . . you don't need to maintain costly inventory records. *With Veelos, you have the right size v-belt for any drive in your plant—all the time!*

Veelos on reels saves valuable storage space. It simplifies stock records; it eliminates belt deterioration and obsolescence.

Veelos is simple and easy to install. No need to dismantle drives with fixed centers or outboard bearings . . . no long, expensive interruptions to production. Just loop it around the sheave and couple the ends.

Check the advantages of Veelos and you'll agree that it can provide substantial savings for you.

Everyone responsible for power transmission needs this Veelos data book. Gives complete engineering data, measuring and installation directions. Shows Veelos at work on scores of different drives in many different industries. Write and we'll send you a copy *free!*

MANHEIM MANUFACTURING & BELTING COMPANY
MANHEIM, PA.

VEELOS
THE LINK
V-BELT

ADJUSTABLE TO ANY LENGTH • ADAPTABLE TO ANY DRIVE

Made in all standard sizes, fits all standard grooves. Packaged on reels in 100-foot lengths. Sales engineers in principal cities; over 350 distributors throughout the country. Veelos is known as VEELINK outside the United States.

Sometimes
it costs less
to use Steel
that costs more!

Here, U·S·S COR-TEN used cuts weight 18%

*** The bigger the tank the bigger the saving**

In the 42" x 10' Stonesteel tanks under construction above, the use of COR-TEN reduces weight 553 lb., saves $5.00 on material cost. When these lighter COR-TEN tanks were shipped to a housing development in Norfolk, Va., freight charges were $9.84 less, bringing the total savings per tank to $14.84.

in place of carbon steel

cuts material cost 10.8%

cuts shipping cost 16%

During the past 12 years, U·S·S Cor-Ten—the pioneer high strength steel—has earned a world-wide reputation for reducing costs by reducing weight in freight cars, buses, trucks and other mobile equipment. That's exactly what Cor-Ten was developed for, so we were not surprised.

But here is the story of a money-saving application, far outside the transportation field, that aptly illustrates how stationary equipment of many kinds can be built advantageously of U·S·S Cor-Ten in place of carbon steel—not only to improve the product but to reduce its cost.

SEVERAL years ago the Cemline Corporation of Cheswick, Pa., developed a hot water storage tank designed to prolong life even in those areas where water supplies are unusually corrosive. A special hydraulic cement lining that prevents corrosion by eliminating any corrosive water-to-metal contact did the trick. But in solving the corrosion problem the cement lining created another. Its substantial weight when added to the weight of the heavy carbon steel shell resulted in a unit that was unwieldy to handle and difficult and costly to install.

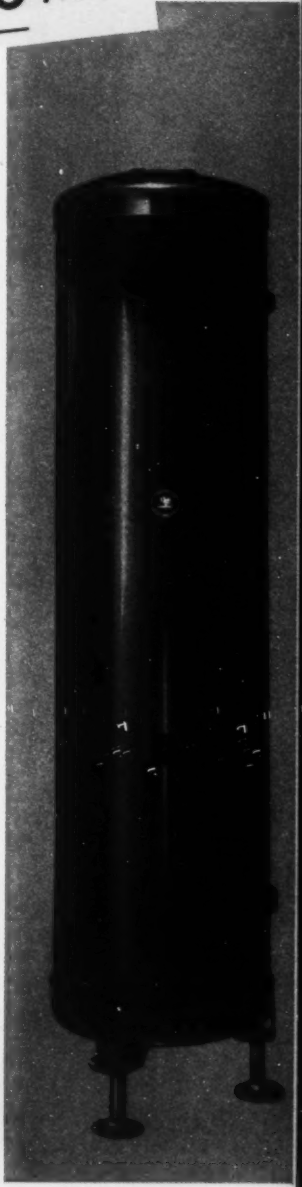
A lighter tank was definitely called for. This need was emphasized with every increase in freight rates, and as more and more tanks were shipped to distant markets. The question was, how to reduce weight and still meet high strength requirements. Cemline engineers found the answer in U·S·S Cor-Ten.

Due to the protective lining, interior corrosion could be disregarded, so they were able to take full advantage of U·S·S Cor-Ten's high yield point (50,000 psi.) and to use it in gages 40% lighter than the carbon steel gages previously required. This 40% reduction in cylinder weight reduced the total tank weight 18%.

These weight savings resulted in cost savings all along the line. Cost of the steel per cylinder was 10.8% less (because the weight saved more than offsets Cor-Ten's slightly higher cost). The lighter tanks were handled with less trouble and less expense. And, freight charges on every shipment—on steel from the mill, on the tanks to the customer—were reduced almost 16%.

To show what this means in actual dollars and cents savings, take the case of the 45-gallon Stonesteel tank (shown at right) produced by the thousands for residential use. Replacing the carbon steel shell, .138″ thick, with U·S·S Cor-Ten .0828″ thick, reduced weight 42 lb., cut steel cost 35 cents. When these tanks were shipped to Richmond, Va., freight charges were 72 cents less for the lighter tanks, making a total saving per tank of $1.07.*

"U·S·S Cor-Ten," says the President of Cemline Corporation, "does more than reduce our costs. Because of its stiffness it forms more smoothly on our bending rolls, and fluting difficulties formerly experienced have disappeared. In welding, too, Cor-Ten behaves better than straight carbon steel. It does not seem to burn away so readily under the arc and thus makes welding easier and faster. We know our customers have less trouble and less expense handling these lighter Cor-Ten tanks. And because Cor-Ten has from 4 to 6 times greater atmospheric corrosion resistance we have every reason to believe that Stonesteel tanks made of U·S·S Cor-Ten are much less likely to rust when exposed to external condensation, when leaky fittings drip or when the enameled surface is damaged in shipping or installation. That's why, for all our tanks, except where codes require flange steel construction, we've standardized on U·S·S Cor-Ten."



AMERICAN STEEL & WIRE COMPANY, GENERAL OFFICES: CLEVELAND, OHIO
CARNEGIE-ILLINOIS STEEL CORPORATION, PITTSBURGH & CHICAGO
COLUMBIA STEEL COMPANY, SAN FRANCISCO · NATIONAL TUBE COMPANY, PITTSBURGH
TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM
UNITED STATES STEEL SUPPLY COMPANY, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

U·S·S HIGH STRENGTH STEELS

U·S·S COR-TEN • U·S·S MAN-TEN • U·S·S MANGANESE-NICKEL-COPPER

United States Steel Corporation Subsidiaries
Room 2088 Carnegie Building, Pittsburgh 30, Pa.

☐ Please send me a copy of booklet showing how U·S·S Cor-Ten saves money in building Stonesteel tanks.

☐ Please have a High Strength Steel representative call on me.

Name..

Position..

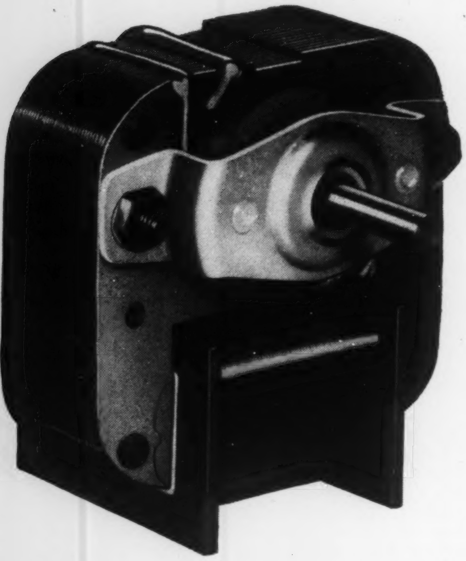
Company..

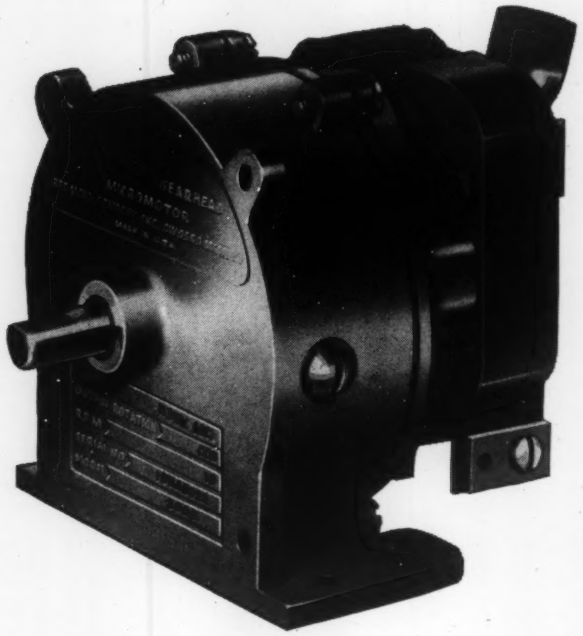
Address..

City..........................Zone.....State............

UNITED STATES STEEL

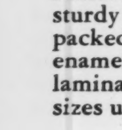
FOR JOBS THAT CALL FOR TOP PERFORMANCE





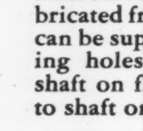
HERE ARE TWO NEW

Redmond MICROMOTORS



2-POLE OFFSET MICROMOTOR

Here's a low cost, skeleton-type Micromotor that is a rugged performer. This 2-pole offset unit is ideal for use in small room heaters, fans, animated displays, and other applications calling for light weight, low power motors. Features include air gap concentricity, sturdy bearing brackets, oil reservoirs packed with felt, and highest quality enameled windings. Two holes in field laminations facilitate mounting. Built in sizes up to 1/100th horsepower.



GEARHEAD MICROMOTOR

This sturdy, quiet-running gearhead unit is for applications requiring unusual r. p. m. specifications. Output selections are almost without limit down to 2 r.p.m. It is powered by a dependable Redmond 2-pole offset Micromotor with a single bearing lubricated from the gear box. Brake device can be supplied if required. Four mounting holes are provided horizontal to shaft on front surface and four vertical to shaft on base surface.

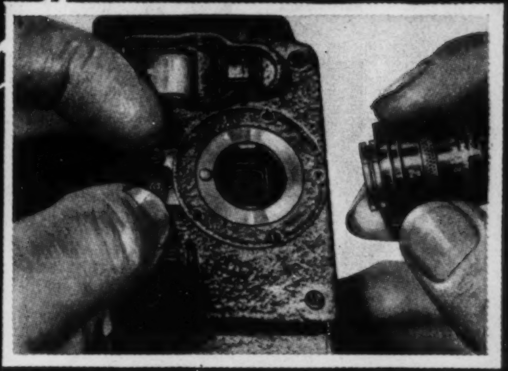
Redmond COMPANY, INC.
OWOSSO, MICHIGAN
Offices in New York, Chicago, Dayton, Los Angeles, Dallas

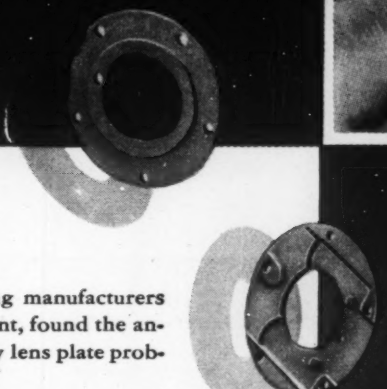
REDMOND

OVER 150
STANDARD MODELS
25
DIFFERENT TYPES

Expanded Facilities • Prompt Deliveries • Service before and beyond the sale

here's how Microcastings [illegible] camera problem





The Bell & Howell lens plate for the Sportster Camera shown above is an example of the intricate design problems involving thin wall sections, close location of holes, and exact tolerances which can be economically solved by the MICROCAST process.

BELL & HOWELL, leading manufacturers of motion picture equipment, found the answer to a critical and costly lens plate problem in MICROCASTINGS.

The intricate, stainless steel lens plate, too complicated for economical die casting or machining, was formerly coined of brass. However, coining dies did not stand up; and the cost of die maintenance was prohibitive.

Today the MICROCAST process has eliminated extensive and expensive die costs as well as machining cost . . . *another example of how* MICROCAST *is serving American industry, solving difficult problems on small castings.*

PARTS NEVER before thought practicable for castings are being MICROCAST and are proving superior for service in consumer as well as commercial products.

Perhaps you have a parts problem involving factors of intricate design, high melting point alloys, or high machining costs. Austenal engineers are at your service and will be pleased to work with you on any of these problems.

New Horizons
MICROCASTING
MICROCAST DIVISION • Austenal Laboratories, Inc.

NEW CATALOG AVAILABLE

A copy of the new 16 page book, "New Horizons with Microcasting," is yours upon request. It is the most complete report ever published on the subject of the MICROCAST process originated by Austenal Laboratories, Inc. See our catalog in Sweet's File for Product Designers.

MICROCAST PRECISION CASTINGS PROCESS

The name MICROCAST is a registered trademark of the Austenal Laboratories, Inc.

MicroCast

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224 East 39th Street • New York 16, New York
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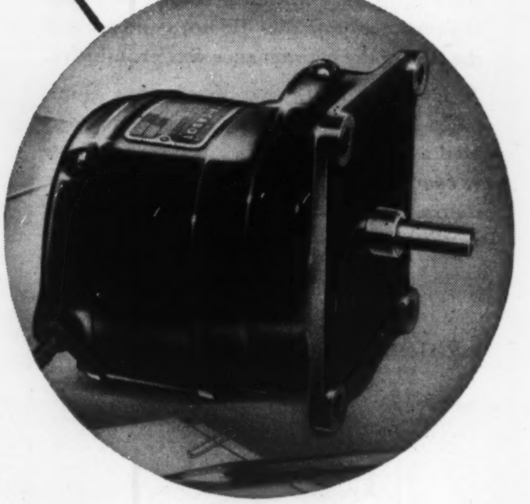
1/30th HORSEPOWER PRECISION MOTORS

Synchronous or induction, split phase or permanent split capacitor, sleeve bearings or ball bearings, with or without gear heads, and in a variety of speeds. Yes, a lot of extra thought went into engineering our broad line of Type R-37 motors. They are built in sizes up to 1/30th horsepower and were created especially for those applications requiring power units between our smaller instrument type motors and our larger commercial types. Specifically they are for devices such as Timers, Electric Typewriters, Recording Instruments, Controllers, Teleprinters, Professional Motion Picture Equipment and Disc, Tape, Wire and Facsimile Recording Devices, Servo Mechanisms, Fans and Blowers. The complete story is told in a new piece of literature. Write or phone today. Ask about the Holtzer-Cabot Type R-37 motors.



Builders of Electric Motors for Three-Quarters of a Century

HOLTZER-CABOT, INC., BOSTON 19, MASS.
OFFICES IN NEW YORK, PHILADELPHIA and CHICAGO
AFFILIATED WITH REDMOND COMPANY, INC.

R. HEAT
HARD
FLEXIBLE
R. SUN
SOFT
R. OIL
R. COLD
ELASTIC
COMPRESSION SET
R. MUD
ELONGATION
R. AGE
R. WATER
LOW DISTORTION
SENSITIVITY
R. CHEMICALS
METAL BONDED
R. WEAR
R. PRESSURE
TENSILE STRENGTH
FABRIC LAMINATED
R. OZONE
RESILIENT
R. ABRASION

R = Resistance to

CHART FOR THE IMPOSSIBLE

To figure out all the conceivable ways that physical characteristics, design variations and resistance properties can be combined in Sirvene parts would be nearly impossible. And a great waste of your time, because only *one* combination will do the job for you. Sometimes even that combination seems impossible—and that's when you need the help of Sirvene engineers. Taking your specific performance requirements, they'll assist you in perfecting the design, then work out the proper combination of oil-resistant elastomers, do the developmental work and produce the parts in quantity under strict laboratory control. You can depend on uniform quality and micrometric accuracy in every part. When you are in a tough spot for the right flexible part to do a critical mechanical protection or sealing job—and to keep on doing it under rough service conditions—call on Sirvene.

OTHER C/R PRODUCTS
PERFECT
Oil Seals
SIRVIS
Mechanical Leather

Sirvene products include diaphragms, boots, gaskets, oil seals, washers, packings, and other special molded mechanical pliables.

CHICAGO RAWHIDE MANUFACTURING CO.
1304 Elston Avenue **SIRVENE DIVISION** Chicago 22, Illinois

SIRVENE

THE *SCIENTIFIC* COMPOUNDED ELASTOMER

Gray Iron for bottle molds must have a mirror-like finish.

Make it with the metal that's *most machinable . . .*

Gray Iron Characteristics Include:

- Castability
- Rigidity
- Low Notch Sensitivity
- Wear Resistance
- Heat Resistance
- Corrosion Resistance
- MACHINABILITY
- Vibration Absorption
- Durability
- Wide Strength Range

Machinability is one of the most important advantages of Gray Iron. Thousands of products, from tiny instrument parts to massive machinery castings, attest to this fact.

Because of its composition and structure, Gray Iron machines easily. The graphite in the iron acts as a lubricant and aids in short chip formation. It can be ground, honed or polished to mirror-like finishes. It is possible to machine Gray Iron castings, then heat-treat to harden and polish to obtain a higher degree of wear resistance.

Are you taking full advantage of the unmatched combination of properties found in Gray Iron . . . plus its ultimate economy?

Write **for free booklet, "GRAY IRON—Its Mechanical and Engineering Characteristics, and Details for Designing Cast Components".**

Make It Better with Gray Iron

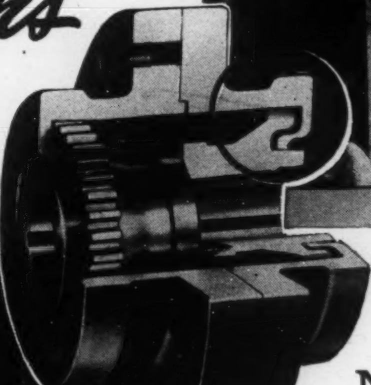
Second largest industry in the metalworking field

GRAY IRON FOUNDERS' SOCIETY, INC.

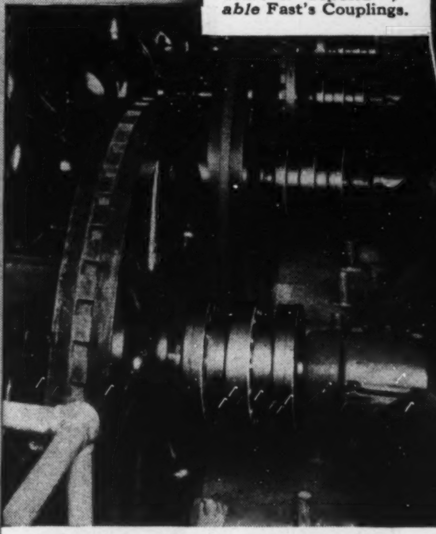
NATIONAL CITY-E. 6th BLDG., CLEVELAND 14, OHIO

Here's Freedom from *Coupling Shutdowns* for ALL INDUSTRIES

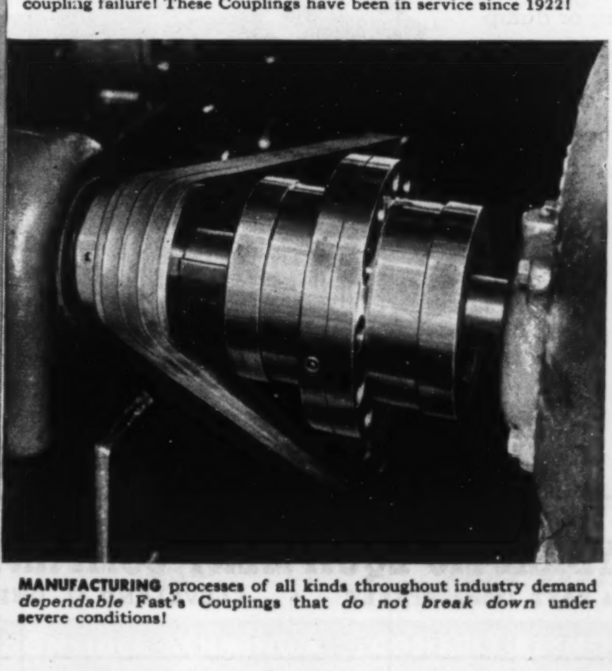
IN OIL FIELDS Fast's are in service to compensate for shaft misalignment, in all kinds of weather, subject to moisture, dirt and grit . . . yet they transmit power without costly coupling shutdowns!



Here's the *exclusive* "rocking bearing," heart of *dependable* Fast's Couplings.



CHEMICAL PROCESSING plants use Fast's Couplings because *exclusive* metal-to-metal seal keeps out impurities—eliminates lost time due to coupling failure! These Couplings have been in service since 1922!



MANUFACTURING processes of all kinds throughout industry demand *dependable* Fast's Couplings that *do not break down* under severe conditions!

No matter what you make—no matter how much horsepower you use in a year—Fast's Couplings virtually eliminate all coupling failure in your plant! There are *no perishable parts* to wear or fail in Fast's! Nothing to replace . . . they're easy to maintain. Even the load-carrying oil is *completely guarded* by a positive metal-to-metal seal formed by exclusive "rocking bearing" principle of construction.

With Fast's on your job you can forget about coupling shutdowns. Correctly engineered position of oil-protecting "rocking bearing" allows for *freedom of movement* to compensate for misalignment because its *spherical base* has *the same axis* as the hub spline faces. No perishable packing rings are used at this critical spot . . . or elsewhere!

When you order Fast's you get years of top engineering experience, Koppers' high standards of workmanship and unexcelled service, including available parts if required by change of drive, *even if your Fast's have been running for 30 years!* For full information mail the coupon below. Address Koppers Co., Inc., Fast's Coupling Dept., 258 Scott Street, Baltimore 3, Md.

KOPPERS

FAST'S
Self-Aligning
COUPLINGS

SEND FOR FREE CATALOG!

KOPPERS CO., INC., FAST'S COUPLING DEPT.,
258 Scott Street, Baltimore 3, Md.

Please send me the free catalog that gives complete detailed information about Fast's Couplings.

NAME.................................TITLE...............

COMPANY..

ADDRESS..

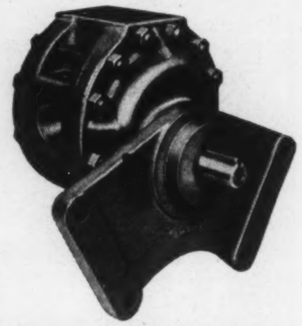
CITY...........................ZONE........STATE...........

mail today

DO YOU USE *Oil Hydraulics?*

YOU CAN'T BEAT HYDRECO FOR TOUGH JOBS!

An outstanding example of a tough assignment for hydraulics is this front end wheel loader manufactured by Tractomotive Corporation, Deerfield, Ill. For their Tracto-Loader, Model TLW, they are using HYDRECO pumps, valves and cylinders for the entire hydraulic system.



- A HYDRECO 200 Series oil hydraulic gear pump, connected directly to the tractor engine of the loader, furnishes a steady and dependable flow of power to the hydraulic system at pressures up to 1000 p.s.i. or more. Other HYDRECO pump models are available with capacities from 2 g.p.m. to 130 g.p.m. — flange or base mountings — direct or pulley drive.
- A HYDRECO V4 Series Hollow-Plunger* valve quickly and accurately controls bucket action. Check valves built right into the Hollow-Plunger also hold the bucket control cylinders in position. No time is lost in building cylinder pressure to go into dig or dump positions. Momentary load drops are entirely eliminated.
- HYDRECO cylinders, the product of careful design and long experience, are built to handle tons of material day in and day out under the severest conditions. Special wiper rings keep dirt and grit out, while high pressure packings keep oil in.
- HYDRECO equipment will improve the performance of your equipment. We will welcome the opportunity to discuss your oil-hydraulic problems with you.

WRITE FOR CATALOG AND FULL INFORMATION

* Hollow-Plunger protected by existing U.S. and Foreign Patents as well as patents applied for.

Write to

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HYDRAULIC CONTROL DEVICES
PUMPS · CYLINDERS · VALVES

HYDRAULIC EQUIPMENT COMPANY
1106 EAST 222nd STREET • CLEVELAND 17, OHIO

MACHINES MADE LIGHTER, MIGHTIER, WITH REYNOLDS ALUMINUM

Photo courtesy Thomson Machinery Co., Thibodaux, La.

MUCH of the cost of raising sugar cane is in the cutting. The cane harvester in the picture above used to be overweight, had trouble getting over wet ground until aluminum replaced many heavy parts.

The manufacturer redesigned with aluminum—used aluminum bar and structurals in the frame work, replaced cast iron gear cases with strong, heat-treated aluminum castings. In fact, nearly 30% reduction of dead weight was made without sacrifice of strength. This allowed more engine—30 hp was added—never attainable with heavier metals. Now more cane is cut faster and harvest costs are lower, because lighter aluminum enabled the making of a mightier machine.

Here's proof of the part aluminum can play in improving your product. There are many kinds of aluminum that do many different jobs, better. Aluminum lets you forget rust, gives you a metal that's easier and faster to handle; it's strong even though ⅓ the weight of other metal. You can save on finishing cost—aluminum's bright natural finish stays bright. Shipping costs are less and sales appeal is tops. You can have all these benefits in extrusions, structurals, sheet, screw machine stock, wire, rod, bar and special shapes—in a wide range of alloys and tempers.

To get the lift of aluminum for your product, get the help of Reynolds experenced technicians. Call the nearest Reynolds Office, listed under "Aluminum" in the classified section of your telephone directory, or write to Reynolds Metals Company, Aluminum Division, 2521 South Third Street, Louisville 1, Kentucky.

ALUMINUM STRUCTURAL DESIGN

Send your request for this informative book on your company letterhead and receive your copy without charge.

IF YOU SEE RUST YOU KNOW IT'S NOT ALUMINUM

REYNOLDS METALS

REYNOLDS *Lifetime* ALUMINUM

CONSIDER ALUMINUM . . . CONSULT REYNOLDS . . . THE COMPLETE ALUMINUM SERVICE

APPLY THE RIGHT LUBRICANT • IN THE RIGHT QUANTITY • AT THE RIGHT TIME

DESIGN ENGINEERS!

LINCOLN
LUBRICATING
SYSTEMS

Don't Overlook the Importance of Modern Lubrication Systems

The Application of the Right Lubricant . . . In the Right Quantity . . . At the Right Time is of paramount importance in machine design.

Today's demand for lower production costs and higher efficiency have created added responsibilities for design engineers . . . Designing practices for the application of lubricants have been confined to the random selection of grease fittings, or oil cups, and without benefit of engineering knowledge, and consequently without assurance that the right lubricant would be applied, or that it would reach the bearing in the right quantity or at the right time.

Lincoln Systems are engineered to specific bearing requirements regardless of the type of machine.

The new Lincoln Catalog, illustrated at right, appears in the current issue of Sweet's File for the Product Designer. It gives you valuable information. Refer to it and enlist the aid of your local Lincoln Distributor or any of our Sales and Service Offices. Trained lubrication engineers are ready to help you.

4f
2

Lincoln Standardized
LUBRICATION SYSTEMS
for STANDARDIZED
CENTRALIZED
MASS LUBRICATION

Serving All Major Industries

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- **PORTLAND**—Pioneer Equipment Co.—Lancaster 0488

• • **PIONEER BUILDERS**

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LUBRICATING EQUIPMENT • •

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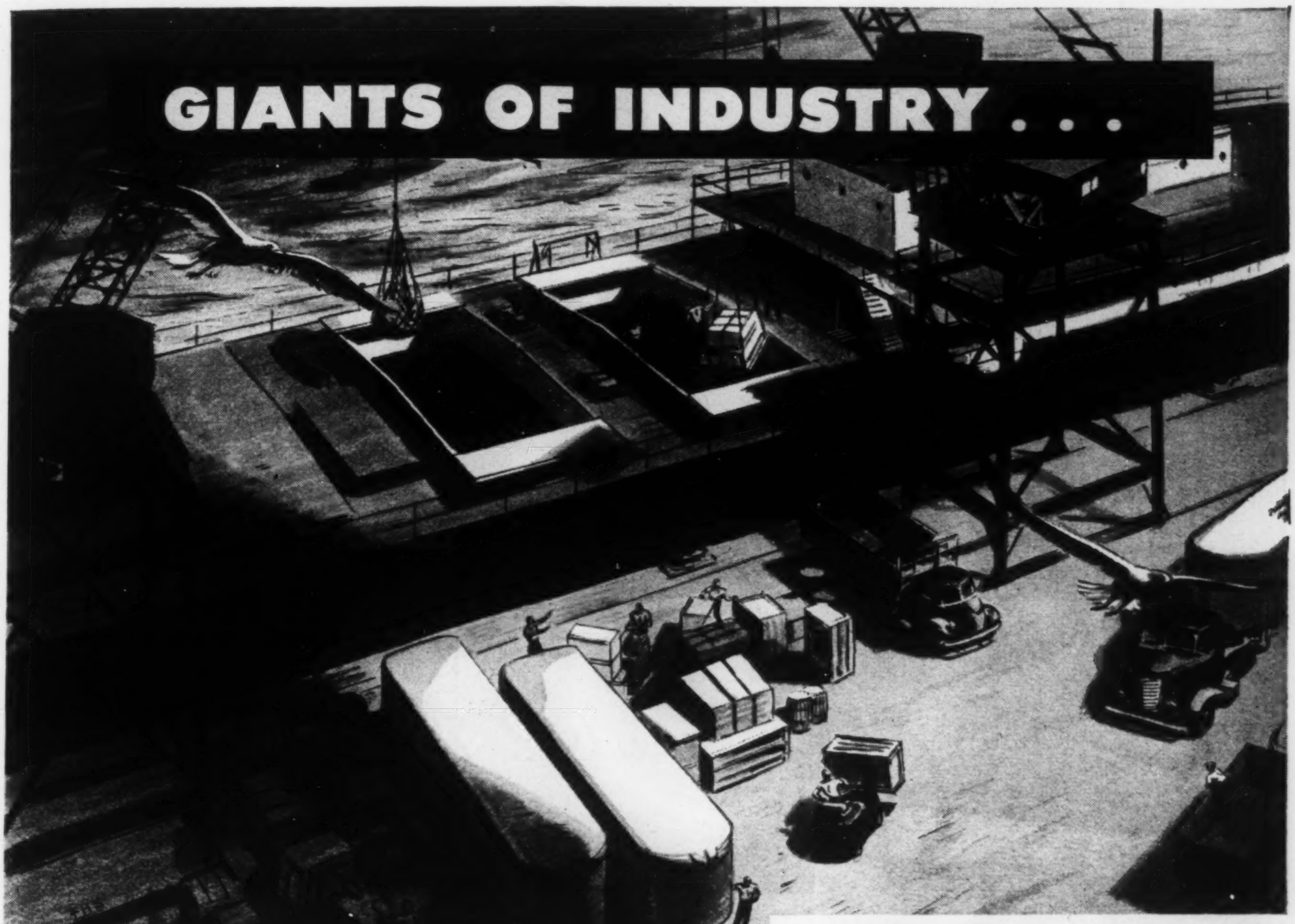
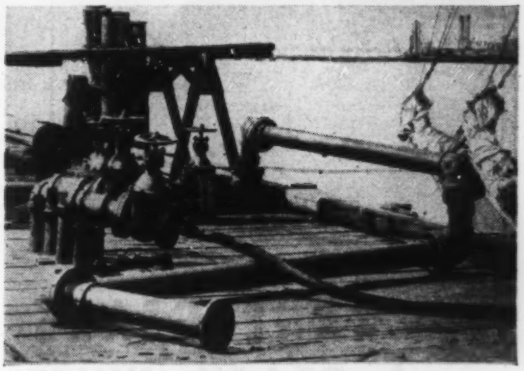
LINCOLN ENGINEERING COMPANY • 5736 NATURAL BRIDGE AVE., ST. LOUIS 20, MO.

GIANTS OF INDUSTRY . . .





BARCO JOINTS ON WHARF LOADING LINES **combine complete flexibility with long life. Also Barco Joints on loading and unloading lines are available in magnesium which permits extreme ease of handling because of their light weight.**

. . . AND BARCO JOINTS KEEP THE FLUID LINES *FLEXIBLE*

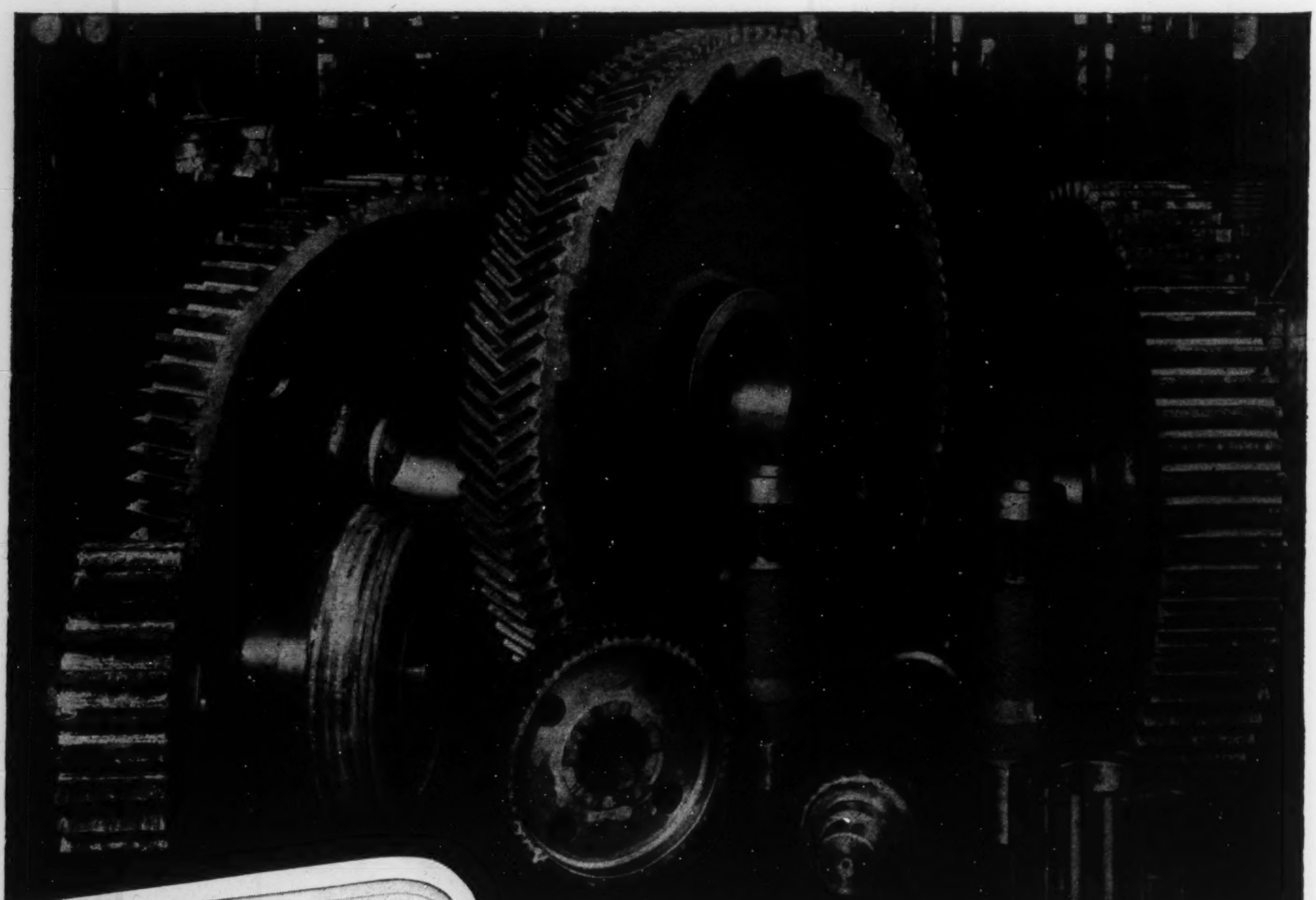
Because there is always movement—vibration, expansion, contraction—in any fluid-conveying system, Barco Flexible Joints are needed to provide responsive, compensating movement through every angle. Everywhere in industry and transportation, you will find Barco protecting the arterial systems which convey oil, gasoline, air, water, steam—the life-blood of America's industrial body. For more complete engineering information, write to Barco Manufacturing Co., 1806D Winnemac Ave., Chicago 40, Illinois. In Canada: The Holden Co., Ltd., Montreal, Can.

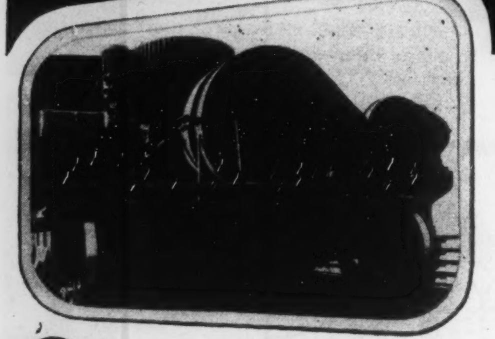
BARCO FLEXIBLE JOINTS

Not just a swivel joint ...but a combination of a swivel and ball joint with rotary motion and responsive movement through every angle.

FREE ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY

"MOVE IN EVERY DIRECTION"





CRANE GEARS and TRACK WHEELS have *Greater Internal Stress Value . . .*

HERE IS WHY

FOR COMPARATIVE PURPOSES

we tabulate below the physical properties of the surface and core values of SAE-1020, SAE-2315, Steels, Carburized or Case Hardened with "NELOY" and "NELOY-MOLY" Steels Normalized or Liquid Quenched, Finish Machined and Flame Hardened.

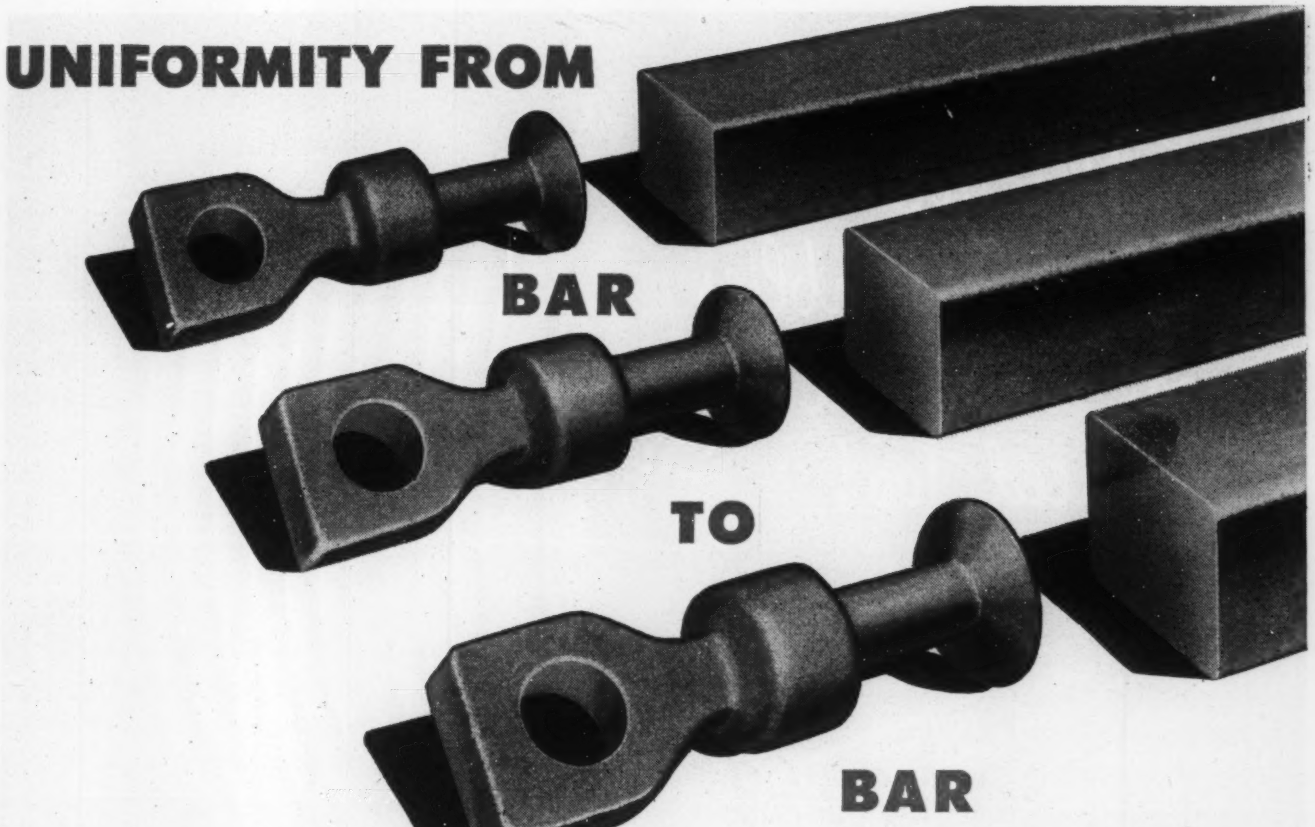
	Ultimate Tensile Lbs. per Sq. In.	Elastic Limit or Yield Point Lbs. per Sq. In.	Elongation Percent	Reduction of Area Percent	Brinell	Sclero-scope
S.A.E. 1020 Case Hardened (Surface)...	260/300,000	180/195,000	5–10	8–12	514–601	71–81
S.A.E. 1020 Case Hardened (Core).....	60/ 70,000	30/ 35,000	30–35	40–50	120–140	17–20
Neloy Annealed and Flame Hardened Treatment 10B (Surface)..........	218/270,000	190/240,000	8–12	20–35	477–590	66–80
Neloy Annealed and Flame Hardened Treatment 10B (Core)............	85/ 90,000	55/ 65,000	23–40	30–40	163–170	23–24
S.A.E. 1020 Case Hardened (Surface)...	260/300,000	180/195,000	5–10	8–12	514–601	71–81
S.A.E. 1020 Case Hardened (Core).....	60/ 70,000	30/ 35,000	30–35	40–50	120–140	17–20
Neloy Heat-treatments No. 3 and 10B (Surface).........................	220/270,000	200/240,000	8–12	20–35	550–590	68–80
Neloy Heat-treatments No. 3 and 10B (Core)............................	100/110,000	80/ 90,000	20–26	40–50	202–240	29–33
S.A.E. 2315 Case Hardened (Surface)...	290/329,000	185/205,000	4– 8	6–10	570–653	78–87
S.A.E. 2315 Case Hardened (Core).....	112/129,000	99/120,000	12–20	38–51	249–275	35–39
Neloy-Molybdenum, Normalized, Drawn and Flame Hardened (Surface)	258/281,000	212/247,000	6–10	8–12	514–555	71–75
Neloy-Molybdenum, Normalized, Drawn and Flame Hardened (Core)	90/110,000*	65/ 85,000*	18–25	30–40	190–220	28–33
S.A.E. 2315 Case Hardened (Surface)...	290/329,000	185/205,000	4– 8	6–10	570–653	78–87
S.A.E. 2315 Case Hardened (Core).....	112/129,000	99/120,000	12–20	38–51	249–275	35–39
Neloy-Molybdenum Heat-treatments 3A and 10B Flame Hardened (Surface)	282/318,000	217/265,000	4– 8	6–10	555–627	75–84
Neloy-Molybdenum Heat-treatments 3A and 10B Flame Hardened (Core)	132/150,000	120/135,000	10–18	25–35	290–320	41–45

***The variation in tensile and yield in the third table is due to the alloyed elements of 2315 which is a nickel steel. This produces a higher physical on a straight annealed steel compared with more economical alloy used in Neloy Moly.**

NATIONAL ERIE CORPORATION

ERIE, PENNSYLVANIA • U. S. A.

UNIFORMITY FROM BAR TO BAR



means uniformly better forgings for you

THE same forgeability . . . the same superior surface and internal quality . . . the same response to heat-treatment and the same machinability . . . in bar after bar and heat after heat!

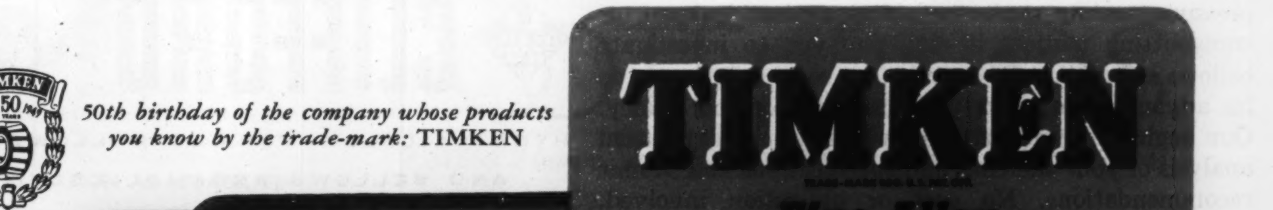
That's what customers have learned to expect from Timken® forging bars.

This unexcelled uniformity helps to maintain consistently high quality in your forged parts. It means better finish, fewer rejects, fewer delays and fewer changes in shop practices. It insures steadily maintained high forging output, at minimum production cost.

Timken quality control uses the most precise methods ever developed to maintain unexcelled uniformity in alloy steel forging bar stock. Many special practices employed in the Timken plant are only practical in such a large, flexible specialty mill.

Timken alloy steels are tailor made to meet your specifications for chemical and physical properties. For help with your problems, write us today. Ask for our 112-page book, "Evaluating the Forgeability of Steels". The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, O. Cable address: "TIMROSCO".

50th birthday of the company whose products you know by the trade-mark: TIMKEN



Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard tool analyses—and alloy and stainless seamless steel tubing.

Maybe Bellows Assemblies are what you need, too!

Temperature control instruments that make travel on passenger trains safer and more comfortable rely for accurate, dependable performance on Clifford Thermostatic Bellows Assemblies designed especially for the job to be done.

Whether your problem is controlling temperature or pressure, sealing shafts or valves against leakage, or transmitting motion, it may pay you to investigate bellows assemblies. Doing it before your designs are too far advanced may save you time, trouble and money. Our engineering department will make a confidential analysis of your sketches and specifications and submit recommendations. No cost or obligation involved. CLIFFORD MANUFACTURING COMPANY, 124 Grove St., Waltham 54, Massachusetts. *Division of Standard-Thomson Corporation.* Offices in New York, Detroit, Chicago, Los Angeles.

HYDRON Metal Bellows

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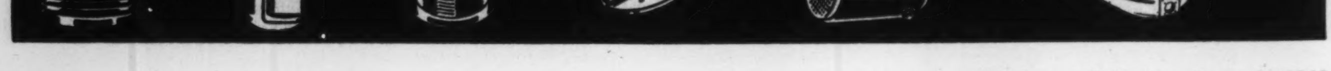
ALL-ALUMINUM OIL COOLERS FOR AIRCRAFT ENGINES


Instrument Bellows
Aircraft Bellows Assembly
Steam Trap Bellows Assembly
Bellows Seal Assembly
All-Aluminum Cylindrical Oil Cooler
All-Aluminum Oval Oil Cooler

8 reasons why you should choose Maxi-Power Drives

1. HIGH QUALITY GEARING

Alloy steel gears and pinions with gear teeth generated to greater accuracy. Improved methods of heat-treating give increased strength—longer life.

2. HIGH EFFICIENCY

Antifriction bearings—improved accuracy of gears—maintained accurate alignment—effective lubrication assures operating efficiencies.

3. DEPENDABLE PERFORMANCE

Improved design, rugged construction, highest quality materials, accurate manufacture to close tolerances, all assure extreme ruggedness necessary for heavy-duty service over long periods.

4. SMOOTH OPERATION

The overlapping tooth action of the extremely accurate gears, plus close back lash tolerances, provides smooth, quiet operation.

5. MORE POWER—LESS SPACE

The careful engineering, quality manufacture and the use of finest materials permit the selection of a smaller size unit than was previously necessary.

6. POSITIVE LUBRICATION

All gears and bearings are lubricated from a large oil reservoir by a simple, efficient system. Oil seals at all shaft extensions provide oil-tight construction—clean operation.

7. APPLICATION ADAPTABILITY

Many combinations of shaft assemblies permit a wide variety of arrangements of gear drives between prime mover and driven equipment. Any prime mover may be used.

8. WIDE RANGE OF SIZES AND RATIOS

Single, double, and triple units in a range of 42 sizes. Standard ratios from 2.08 to 1 up to 360 to 1 h.p. up to 1350.

More Power in Less Space
WITH THE NEW MAXI-POWER DRIVES

High quality, rugged dependability characterize this new line of enclosed helical gear drives—Maxi-Power by Foote Bros.

These drives are available in single, double, and triple reductions in a wide range of sizes and ratios.

Mail the coupon for Bulletin or call Foote Bros'. representative in your city.

FOOTE BROS. GEAR AND MACHINE CORPORATION
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FOOTE BROS.

Better Power Transmission Through Better Gears

Foote Bros. Gear and Machine Corporation
Dept. O, 4545 South Western Boulevard, Chicago 9, Illinois

Gentlemen:

Please send me Bulletin on MPA Foote Bros. MAXI-POWER DRIVES

Name ____________________
Title ____________________
Company ____________________
Address ____________________
City ____________ Zone ________ State ____________

Steel-Weld FABRICATION

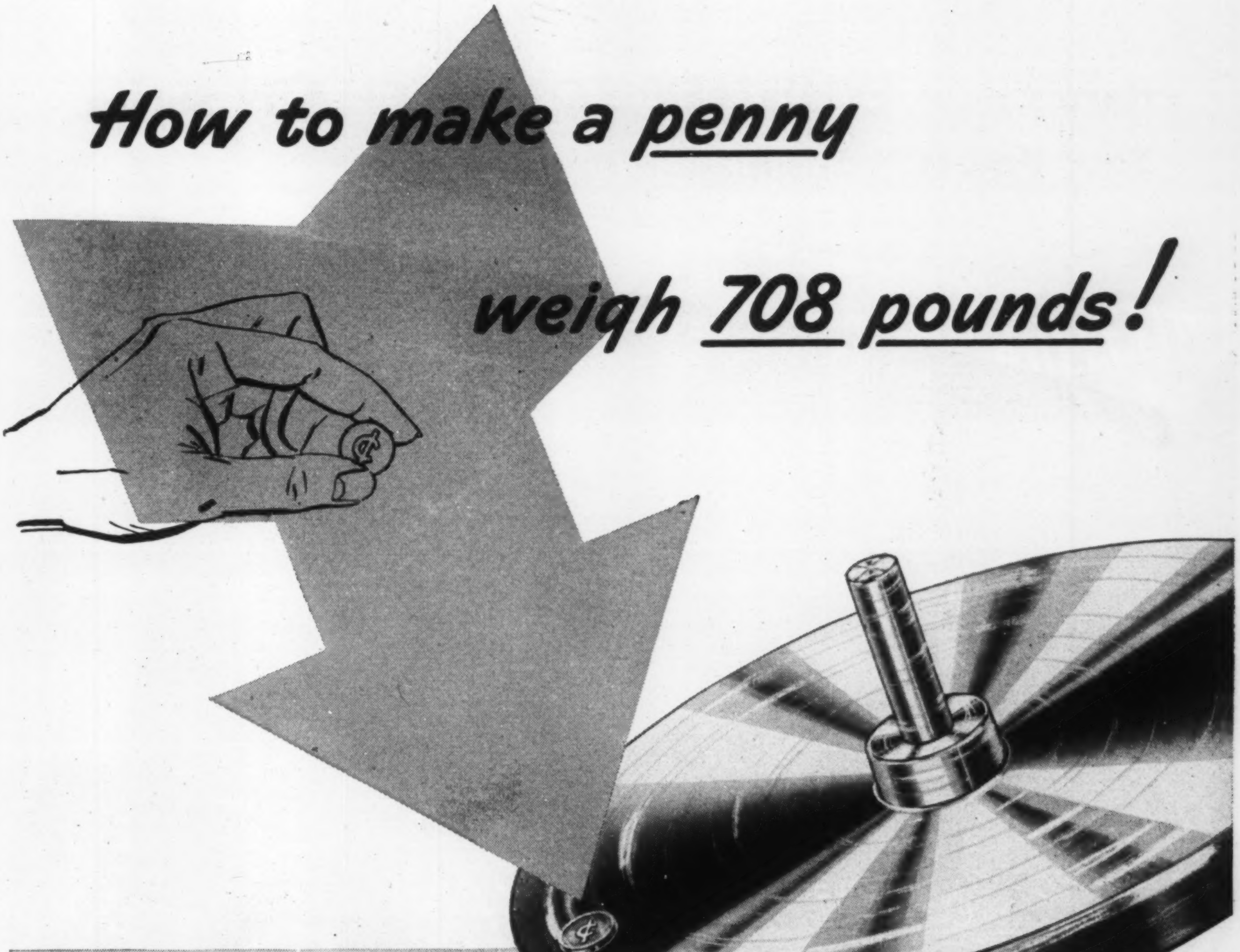
This rotating base for a locomotive crane, which was redesigned by Mahon for Steel-Weld Fabrication, is typical of thousands of Steel-Weld fabricated parts and assemblies produced by Mahon for hundreds of manufacturers throughout the country. Mahon design engineers are available to assist you in initial design or redesign for Steel-Weld Fabrication. This service, backed by craftsmen highly skilled in the welding art, and complete facilities for rough or finished machining—regardless of size or weight—assures you a better, smoother appearing job, embodying every advantage of Steel Weld Fabrication.

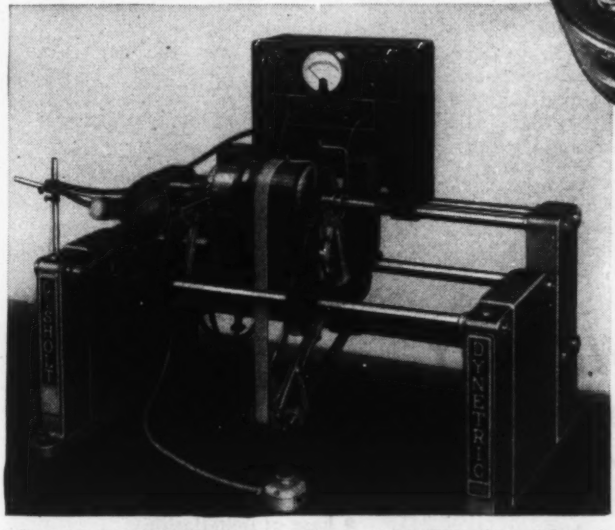
THE R. C. MAHON COMPANY
DETROIT 11, MICHIGAN

Engineers and Fabricators of Welded Steel Machine Bases and Frames, and Many Other Welded Steel Products

MAHON

How to make a penny weigh 708 pounds!





The Gisholt DYNETRIC 3S Balancing Machine shown above is one of many sizes and types available to handle parts weighing from a fraction of an ounce to many tons. Write for literature on the complete line of "S" machines.

Yes, one of those little coppers in your pocket can exert enough "pull" to amaze you.

It's simple dynamics—centrifugal force. To start with, it weighs only ⅛ ounce. Put this "unbalance" weight on a rotating body at 6″ from the center and let's see what happens. At 500 r.p.m. it exerts a force of .44 pound. Now, speed it up. The centrifugal force increases as the square of rotational speed. At 5,000 r.p.m. it becomes 44.25 pounds. At 20,000 r.p.m. the ⅛ ounce becomes a force of 708 pounds on the restraining bearings. Such unbalance in rotating parts causes vibration. And that means trouble in high-speed rotating assemblies—excessive wear, shorter life.

That's why it's so important to specify *accurate* static and dynamic balance in such parts—as a part of design. It's just as important as your specifications for materials and manufacturing tolerances.

World-wide leadership in the field of balancing makes Gisholt your most practical source for help on all balancing problems. Write us.

DYNETRIC BALANCERS GISHOLT

DEVELOPED JOINTLY WITH WESTINGHOUSE ELECTRIC CORPORATION
"DYNETRIC" IS A TRADE MARK
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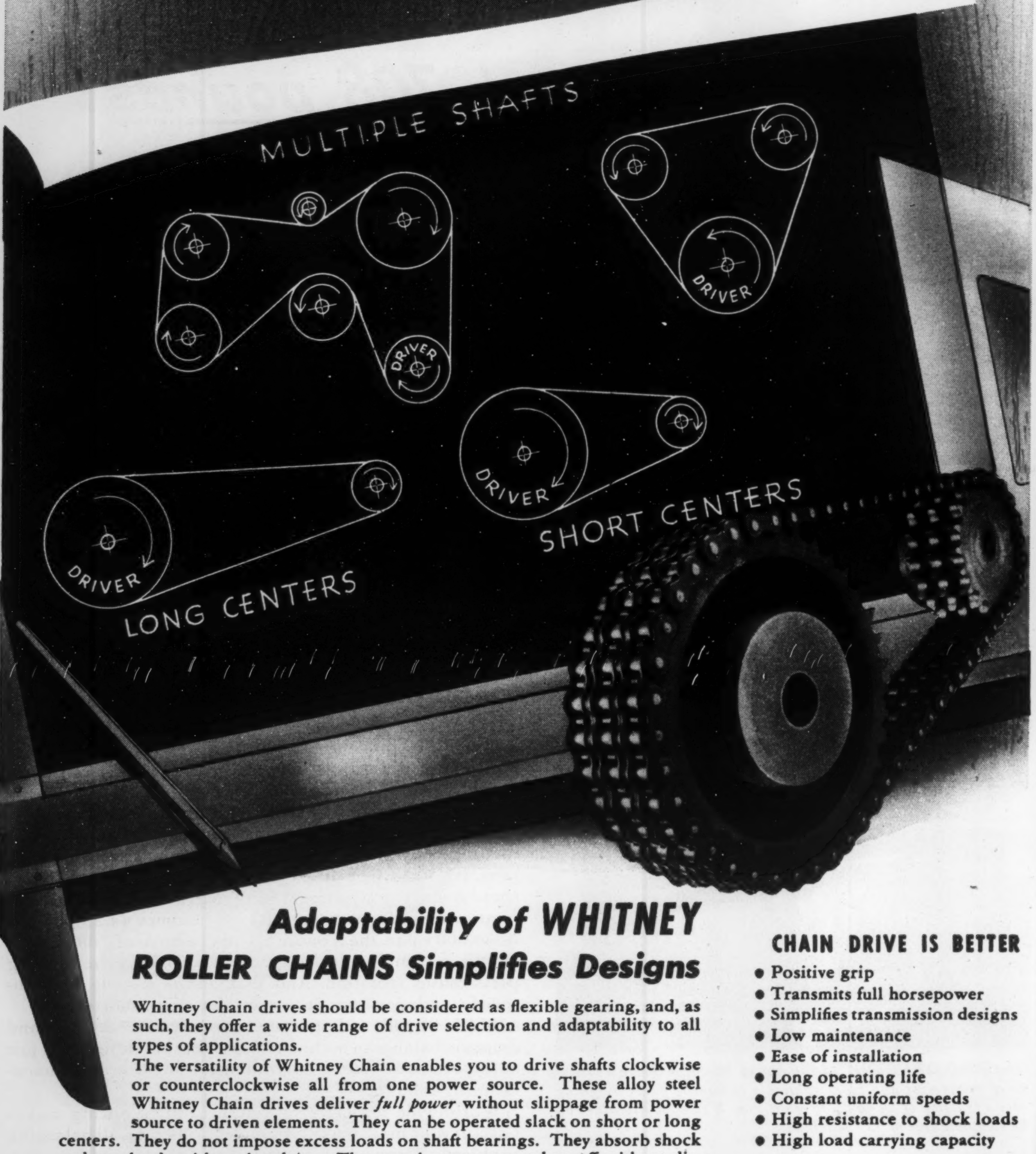
WESTINGHOUSE ELECTRIC CORPORATION

GISHOLT MACHINE COMPANY
Madison 10, Wisconsin

TURRET LATHES • AUTOMATIC LATHES • SUPERFINISHERS • BALANCERS • SPECIAL MACHINES

Here's How WHITNEY ROLLER CHAIN Solves Your Power Transmission Problems



Adaptability of WHITNEY ROLLER CHAINS Simplifies Designs

Whitney Chain drives should be considered as flexible gearing, and, as such, they offer a wide range of drive selection and adaptability to all types of applications.

The versatility of Whitney Chain enables you to drive shafts clockwise or counterclockwise all from one power source. These alloy steel Whitney Chain drives deliver *full power* without slippage from power source to driven elements. They can be operated slack on short or long centers. They do not impose excess loads on shaft bearings. They absorb shock and overloads without breakage. They can be put on or taken off without disconnecting shafts or gears.

No matter what your power drive problems Whitney Chains and Cut Tooth Sprockets . . . *the all-steel drives* . . . will meet your requirements. Write for complete details, today.

WHITNEY CHAIN & MFG. CO.
DIVISION OF WHITNEY-HANSON INDUSTRIES, INC.
205 Hamilton Street, Hartford 2, Conn.

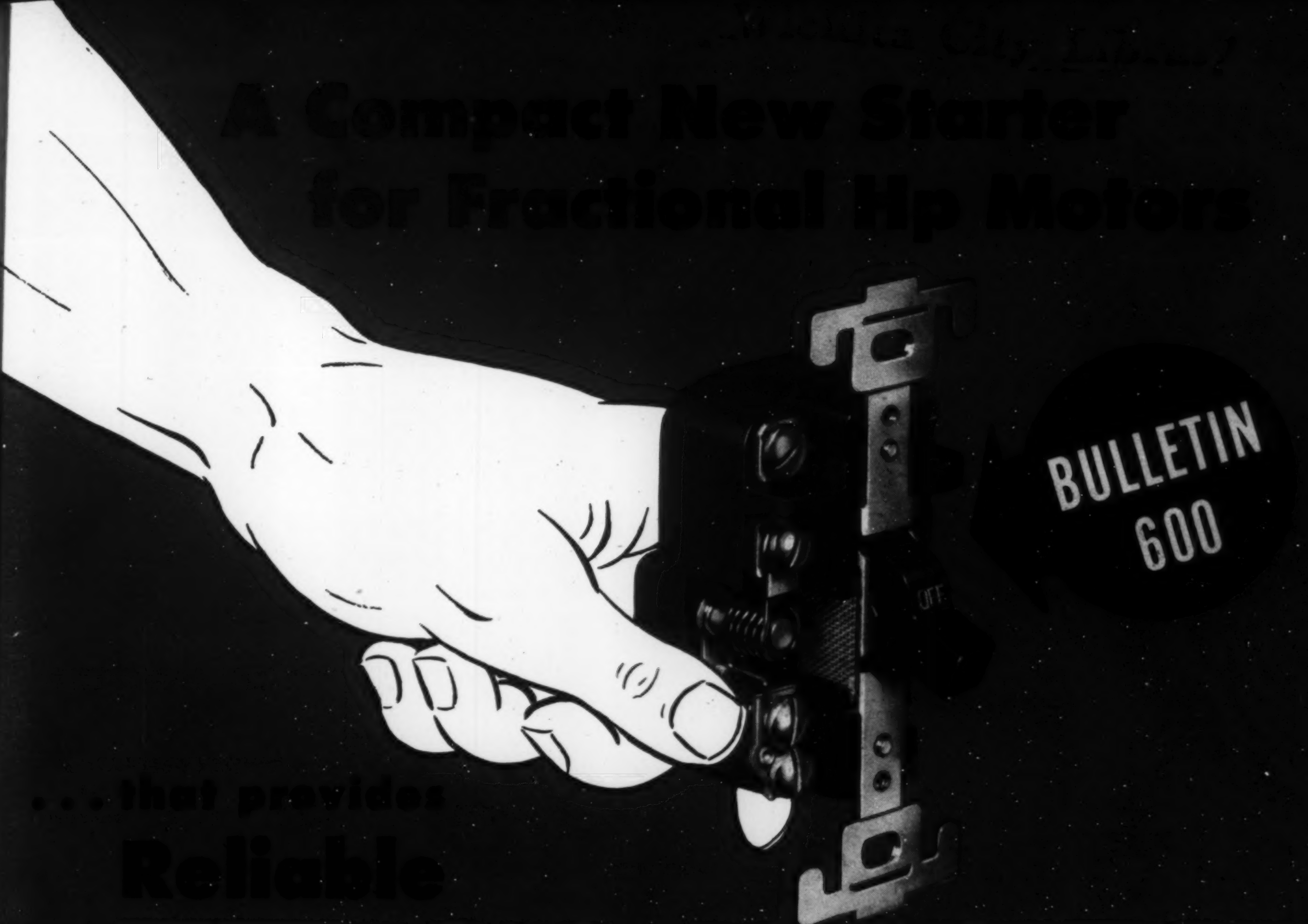
CHAIN DRIVE IS BETTER

- Positive grip
- Transmits full horsepower
- Simplifies transmission designs
- Low maintenance
- Ease of installation
- Long operating life
- Constant uniform speeds
- High resistance to shock loads
- High load carrying capacity

WHITNEY

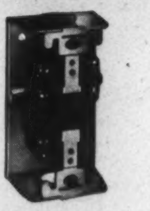
Kansas City Library

A Compact New Starter for Fractional Hp Motors



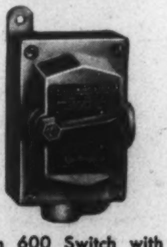
. . . that provides Reliable

OVERLOAD PROTECTION

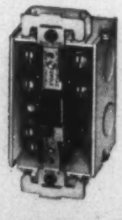


Open view of enclosure for surface mounting

Closed view of enclosure for surface mounting



Bulletin 600 Switch with waterproof enclosure



Bulletin 600 Switch fits any standard switch box

Here is a small, manually operated starter that will satisfy the latest ruling of the National Electrical Code . . . which requires overload protection for a great many fractional horsepower motor applications. The Bulletin 600 Starting Switch is built in the single- and double-pole construction, and is rated one horsepower and less. Its dependable thermal breaker trips the switch under a sustained overload, protecting the motor against burn-out. When the overload is cleared, the breaker is easily reset with the switch lever. However, the switch cannot be held closed so long as the overload condition remains.

The Bulletin 600 Starter is available in enclosures to meet every service requirement. Send for complete data. Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wisconsin.

ALLEN-BRADLEY

BULLETIN 600 STARTING SWITCHES

QUALITY

SEE
OTHER
SIDE

BULLETIN 600...

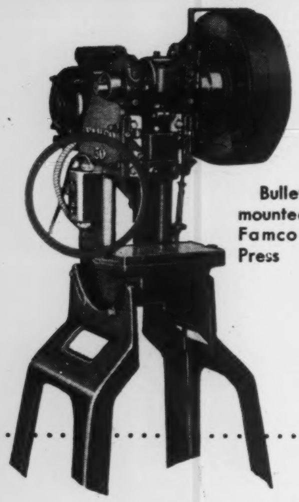
The Popular Starter for Machines Using Motors of 1 Hp or Less

Designed for Modern Requirements

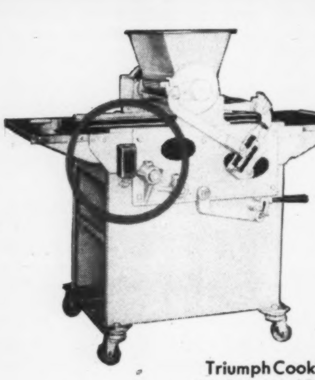
ALLEN-BRADLEY CO.
Milwaukee, Wis.
ON
OFF
Wait 2 minutes then move handle to OFF
MADE IN U.S.A.

This reliable snap switch starter has been redesigned—inside and out—to provide more wiring space . . . more accessible terminals . . . and a far more attractive appearance on your machine.

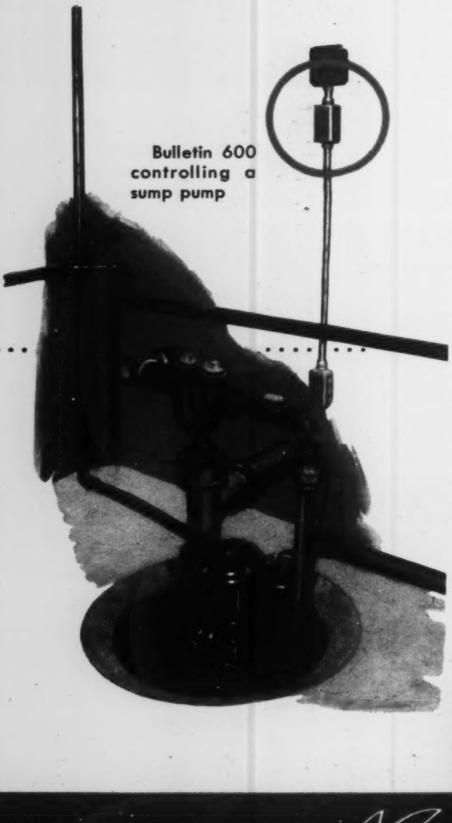
Meets N.E.C. requirements and is a sales asset on any motorized machine.



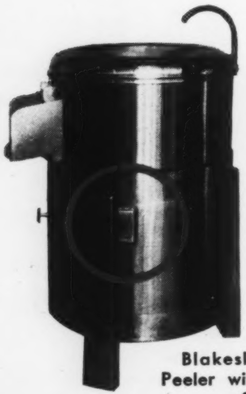
Bulletin 600 mounted on a Famco Power Press



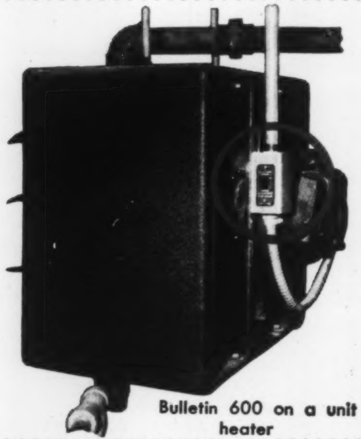
Triumph Cookie Dropper with Bulletin 600



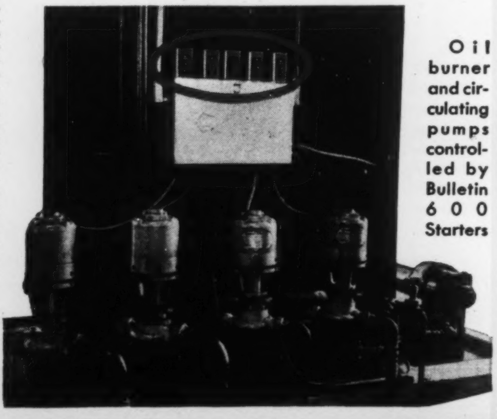
Bulletin 600 controlling a sump pump



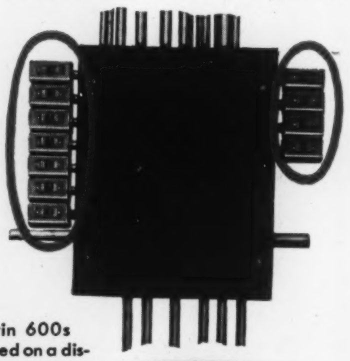
Blakeslee Vegetable Peeler with Bulletin 600 Starter



Bulletin 600 on a unit heater



Oil burner and circulating pumps controlled by Bulletin 600 Starters



Bulletin 600s mounted on a distribution panel

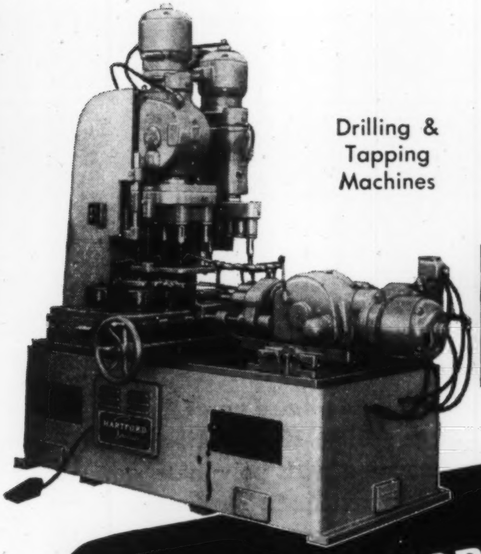
ALLEN-BRADLEY

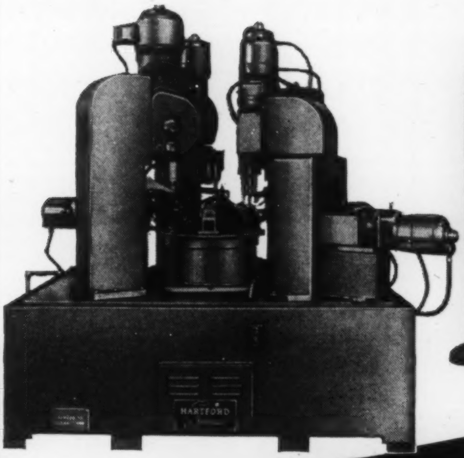
STARTING SWITCHES FOR SMALL MOTORS

QUALITY

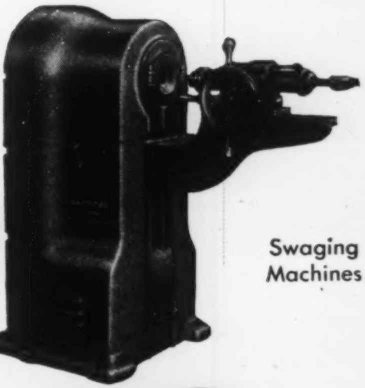
Quality

ALLEN-BRADLEY CO.
1316 S. Second Street
Milwaukee 4, Wis.





Drilling & Tapping Machines

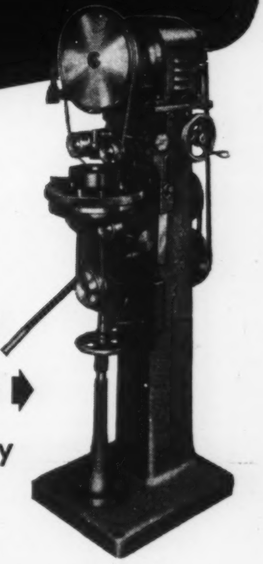


Swaging Machines

THE HARTFORD SPECIAL MACHINERY CO.
HARTFORD, CONNECTICUT
now producing the standard line of

DRILLING & TAPPING MACHINERY
SWAGING MACHINES

formerly manufactured by
LANGELIER MFG. CO.
Cranston, R.I.



in addition to our

Automatic THREAD ROLLERS

DIE POLISHING MACHINES

and complete line of special machinery built to specification

We also manufacture exclusively these famous shop aids

"Super-Spacers"

"Four-Point" Milling Vises

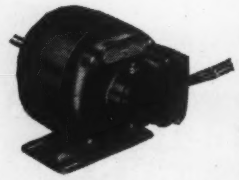
"V-Block" Milling Fixtures

HARTFORD *Special*

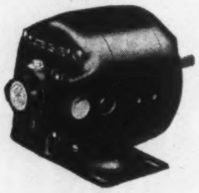
...the standard for special machinery

Designer's

What do you need in a fractional-hp motor?



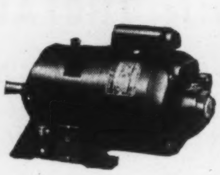
. . . operation on polyphase power? Here it is—the General Electric Type K induction motor for any standard application with polyphase power supply. Use it for pumps, compressors, fans and blowers—wherever the motor must deliver constant speed for long periods. Also available are totally-enclosed motors for machine tools.



. . . operation on d-c power? When the power supply is d-c, use the General Electric Type BC direct-current motor for either constant or adjustable speed. Like all G-E motors, it's quality-built to help sell your product.

. . . constant speed and moderate torque, single phase? Specify this General Electric Type KH split-phase motor for fans, blowers, oil burners, domestic laundry equipment, office appliances, or for general use wherever low-cost operation and quiet, smooth performance are required.

. . . quick starts under load, single phase? Answer the need for high starting torque with a General Electric Type KC capacitor-start motor. It's ideal for motorized tools, domestic water pumping, and commercial refrigeration.



. . . low speed? The wide range of General Electric fractional-horsepower motors also includes compact, easy-to-mount gear-motors (illustrated) for low-speed applications. In addition, there are unit-bearing motors for minimum maintenance, series motor parts for "built-in" power, and many definite-purpose motors.

Quality Motors for Your Product
Fractional-hp Motors
GENERAL ELECTRIC

***New!* An up-to-date fractional-hp motor review** In this booklet, of special interest to machinery manufacturers, you'll find described practically every standard G-E fractional-hp motor made. It contains helpful information on motor selection, operation and construction, plus a list of almost 40 bulletins covering detailed data on individual types. Send for it now—Bulletin GEA-5174.

GENERAL ELECTRIC

Digest

PRODUCT HIGHLIGHTS

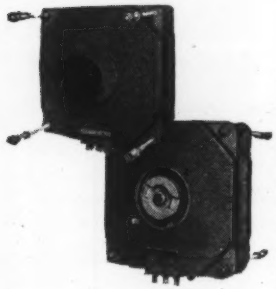
KEEPS RECORDS

photoelectrically!

Direct currents, as well as temperature, speed, pressure, thickness, light and vibration can all be recorded with this versatile General Electric photoelectric recorder. Both the deflection and potentiometer types, using minimum energy, provide direct ink records for quick analysis. Sensitivities are as low as 1.0 microampere full scale, and responses as fast as ¼ second for full-scale deflection. For portable use or semi-flush mounting. See Bulletin GEC-254.

LETS YOU ADJUST SPEEDS

accurately!

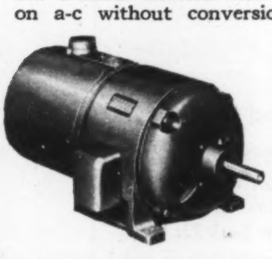


New! For speed control of d-c motors, or voltage control of generators and exciters, you'll want a General Electric plate-type field rheostat. Accuracy of adjustment is provided by many resistance divisions—27, 52, and 70 in the 6- 9- and 12-inch sizes respectively. Adjustable stops may be located at any position between ends of travel. Open (illustrated) and totally enclosed types are made for front or back-of-board mounting. See Bulletin GEC-487.

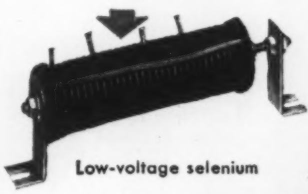
20-to-1 SPEED RANGE

in an a-c motor!

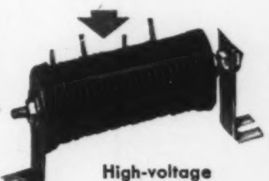
Here's a truly convenient adjustable-speed induction motor—the General Electric Tri-Clad Type ACA—that you can run on a-c without conversion equipment. A turn of the dial, and you get *any* speed over a range of 3 to 1, 6 to 1, or (for intermittent loads) even 20 to 1. And you can get it through remote control, too, with a flexible cable or pilot motor. Do you have possible applications for an adjustable-speed motor with these speed ranges? Write us for specific information, and check Bulletin GEA-4883.



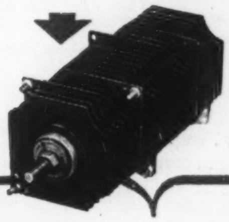
WHEN A-C WON'T DO choose one of these



Low-voltage selenium



High-voltage selenium



Copper-oxide

METALLIC RECTIFIERS

Where you need small amounts of d-c—for example in electroplating, electrolysis protection, blocking relays in control circuits, circuit breaker operation, or power supply for magnetic chucks—get it conveniently from an a-c power source with a General Electric metallic rectifier. To fully meet your needs, General Electric makes all three types, each with special advantages for particular applications. A new, high-voltage selenium type is now available for use where high efficiency, uniformity and space economy are "musts." See Bulletin GEA-5280.

General Electric Company, Section B668-75
Apparatus Department, Schenectady 5, N. Y.

Please send me the following bulletins:

- ( ) **GEA-4883—Type ACA Tri-Clad Motor**
- ( ) **GEA-5174—Fractional-hp motors**
- ( ) **GEA-5280—High-voltage selenium rectifier**
- ( ) **GEC-254—Photoelectric recorder**
- ( ) **GEC-487—Plate-type field rheostat**

CONSULT YOUR McGRAW-HILL ELECTRICAL CATALOG FOR PRODUCT ENGINEERS! You'll find "everything electric" for machinery manufacturers in the General Electric section.

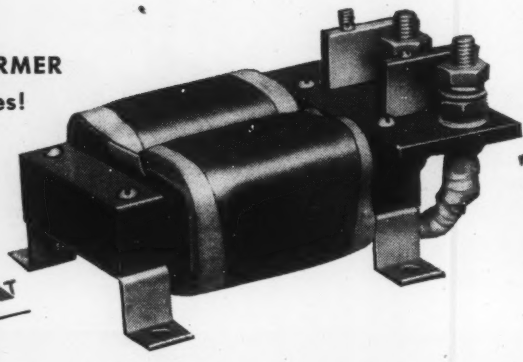
Name...

Company...

Street...

City.......................... State..................

THE G. E. FLYWEIGHT TRANSFORMER
delivering a full kva from 52 ounces!



A DESIGN TO REMEMBER

an example of the application of

electrical insulating materials

made with

FIBERGLAS* *Yarns*

to help achieve **LIGHT WEIGHT** and **COMPACTNESS** in electrical product design

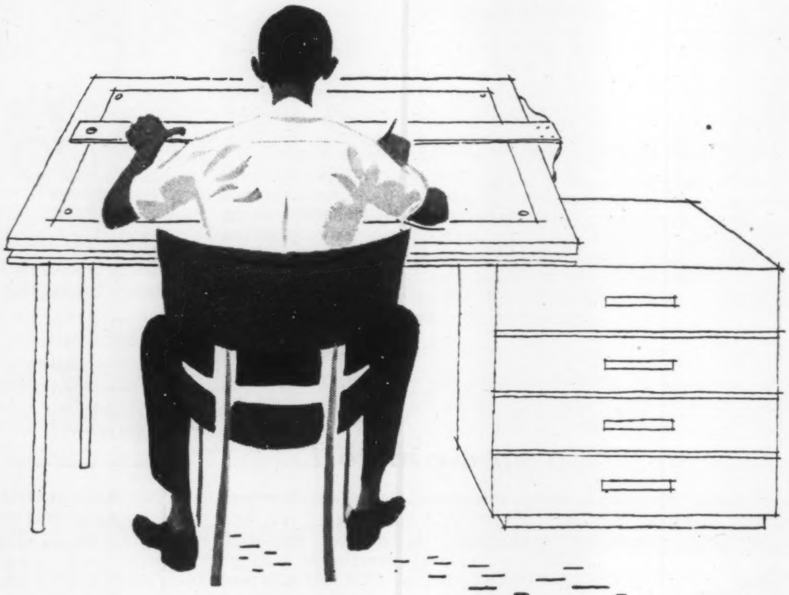
Insulating materials . . . *made of Fiberglas glass yarns* and silicone . . . contribute to the light weight and compactness of the amazing G. E. Flyweight transformer.

The Flyweight is the aircraft autotransformer which G. E. engineers designed smaller and lighter . . . *much smaller and approximately two-thirds lighter* . . . than conventional transformers . . . yet which delivers, ounce for ounce, 3 times the kva over a frequency range of 380 to 1,000 cycles!

That *is* a design to remember.

Specifically, glass and silicone insulating materials are used in this design as: *magnet wire insulation, lead wire insulation, layer insulation, laminate, sleeving, and tape. They are all made with space-saving, weight-reducing Fiberglas yarns.*

High thermal conductivity, plus high resistance to moisture, heat, corrosion, and rot are other basic properties of Fiberglas yarns. They, too, offer definite advantages when insulating materials are part of your product's design.



A new manual of Fiberglas-base insulating materials is just off the press. Send for a copy.

Owens-Corning Fiberglas Corporation,
Textile Products Division, Department
808, 16 East 56 Street, New York 22, N.Y.

OWENS-CORNING
FIBERGLAS *Yarns*

*Fiberglas is the registered trade-mark of Owens-Corning Fiberglas Corporation for a variety of products made of or with glass fibers.

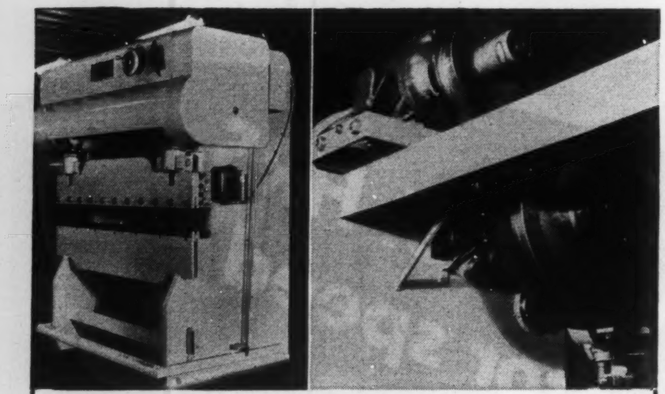
1 REVOLUTION EVERY 5½ HRS.
from normal motor speed

That's just one of the amazingly low speeds and tremendous torques that Janette regularly provides industry, using over 750 different standard gear ratios. Janette also offers more than 2,500 special gear ratios to meet unusual requirements.

For almost half a century Janette engineers have furnished "the right speed and the right power" housed in the most compact, efficient units possible to design. Janette actually helps you reduce costs, improve your product design, strengthen your product sales appeal and increase your plant operating efficiency. Learn how *you* can achieve this with Janette. Write today for our Bulletin 5000.

- gear-motors
- motorless speed reducers
- rotary converters

Janette
MANUFACTURING COMPANY
556 West Monroe Street • Chicago 6, Illinois

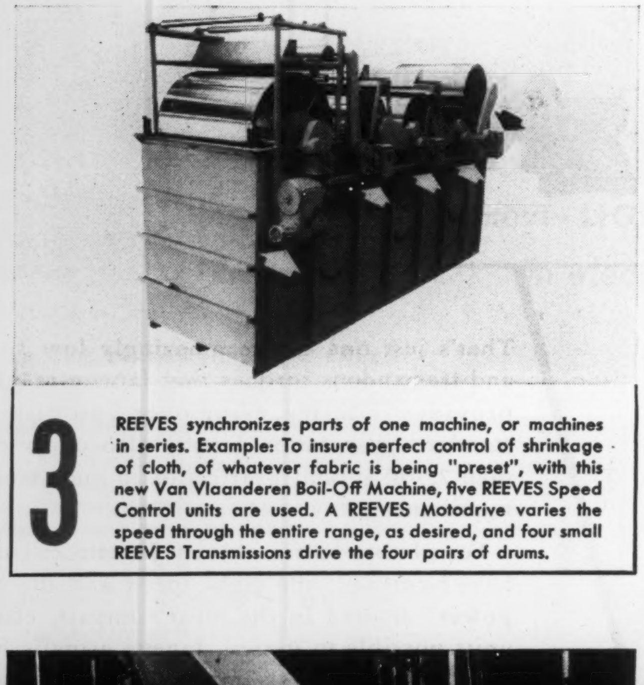


1

REEVES widens the work range of machines—to handle more shapes, sizes, materials. Example: REEVES Vari-Speed Motor Pulley (right) on press brake (left) enables operator to vary ram speed, in bending, braking, punching and other operations, when parts of varying size and weight are in production.

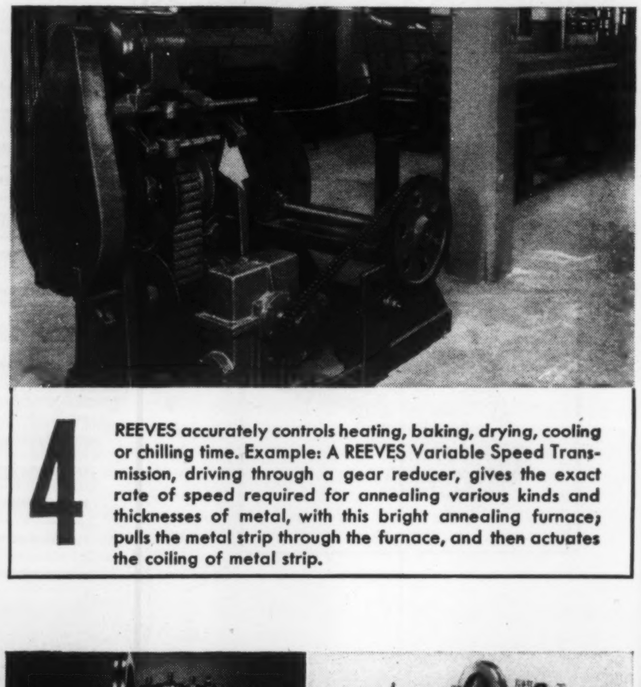
2

REEVES accurately regulates conveyor speeds—even to fractions of an inch per minute. Example: On this Mold Conveyor, used in a Michigan foundry, a REEVES Variable Speed Transmission varies travel speed of parts and co-ordinates the work of men and machinery throughout the foundry.



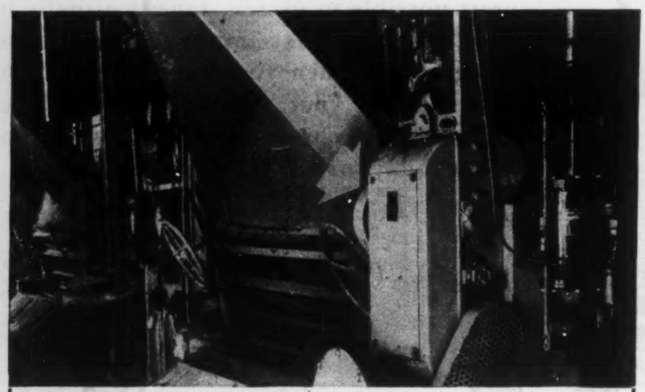
3

REEVES synchronizes parts of one machine, or machines in series. Example: To insure perfect control of shrinkage of cloth, of whatever fabric is being "preset", with this new Van Vlaanderen Boil-Off Machine, five REEVES Speed Control units are used. A REEVES Motodrive varies the speed through the entire range, as desired, and four small REEVES Transmissions drive the four pairs of drums.



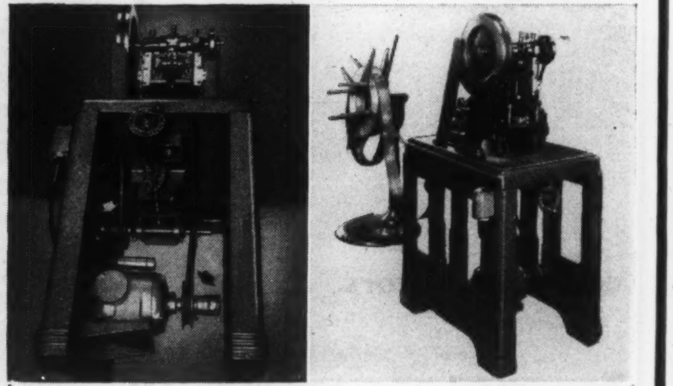
4

REEVES accurately controls heating, baking, drying, cooling or chilling time. Example: A REEVES Variable Speed Transmission, driving through a gear reducer, gives the exact rate of speed required for annealing various kinds and thicknesses of metal, with this bright annealing furnace; pulls the metal strip through the furnace, and then actuates the coiling of metal strip.



6

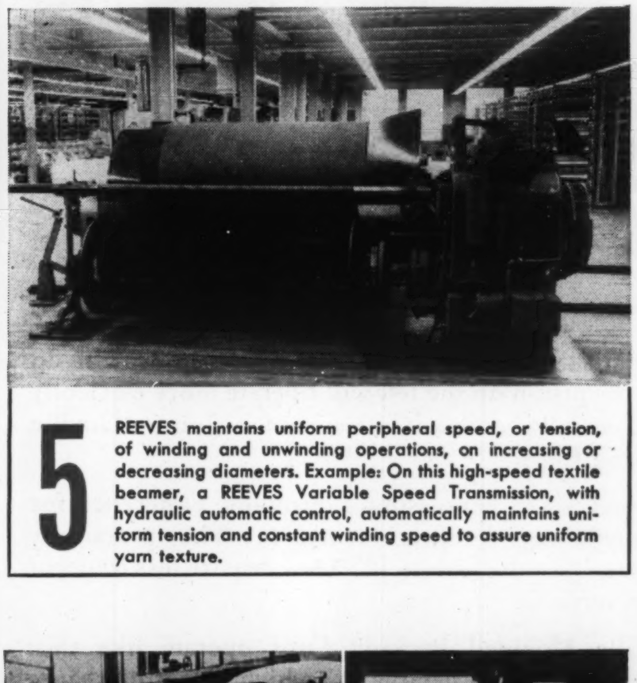
REEVES compensates instantly for variances in weight, liquid level, temperature, etc. Example: To accurately maintain uniform boiler pressure of this stoker, REEVES Variable Speed Transmission automatically increases or decreases speed of the grate travel in response to the steam demand.



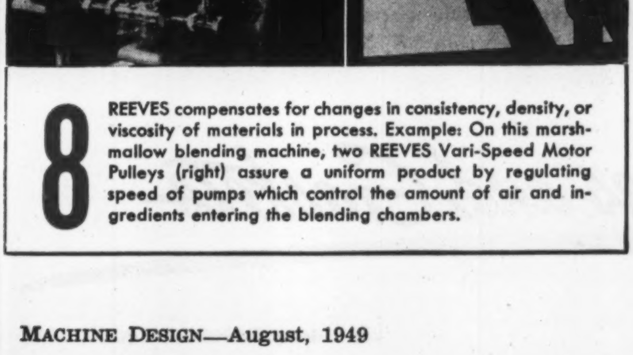
7

REEVES matches variances in number or individual skills of operators. Example: On this automatic stamping and punching press, using a 1740 rpm motor, two REEVES Vari-Speed Jrs. accurately regulate speed of production . . . from 9,000 to 36,000 pieces per hour, according to size, shape and kind of part, and ability of the operator.

8 WAYS REEVES Speed Control helps machine designers hurdle the eight ball



5 REEVES maintains uniform peripheral speed, or tension, of winding and unwinding operations, on increasing or decreasing diameters. Example: On this high-speed textile beamer, a REEVES Variable Speed Transmission, with hydraulic automatic control, automatically maintains uniform tension and constant winding speed to assure uniform yarn texture.



8 REEVES compensates for changes in consistency, density, or viscosity of materials in process. Example: On this marshmallow blending machine, two REEVES Vari-Speed Motor Pulleys (right) assure a uniform product by regulating speed of pumps which control the amount of air and ingredients entering the blending chambers.

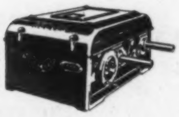
Designers and builders of more than 2,100 different makes of modern machines have already licked their speed control problems by including REEVES Variable Speed Drives as standard equipment. You can do the same. The complete REEVES line of variable speed equipment, built around three basic units, offers you the widest selection of designs, sizes, capacities, and speed ratios—with manual, push-button or completely automatic controls. And REEVES internal operating parts also are available for easy incorporation within the framework of machines. A widely experienced REEVES Speed Control specialist will be glad to recommend the REEVES units best suited to your particular needs. Write for name of the REEVES representative nearest you and for the 114 page catalog H 23-450A.

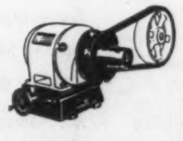
The Three Basic Reeves Speed Control Units

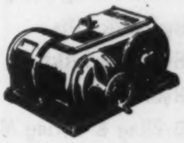
VARIABLE SPEED TRANSMISSION for providing infinite, accurate speed flexibility over a wide range—2:1 to 16:1. Sizes—fractional to 87 hp.

VARI-SPEED MOTOR PULLEY provides an instantly variable speed drive within 4:1 ratio for any constant speed motor. Sizes to 10 hp.

MOTODRIVE combines motor, speed varying mechanism and reduction gears in single unit. Speed variations 2:1 to 6:1 inclusive. Sizes to 20 hp.







REEVES PULLEY COMPANY · COLUMBUS, INDIANA

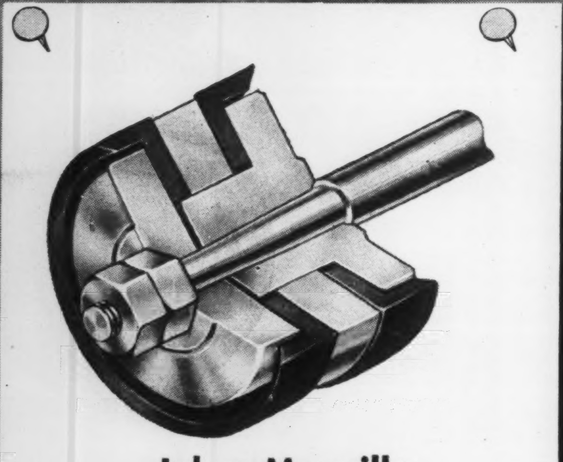
Recognized Leader in the Specialized Field of Speed Control Engineering

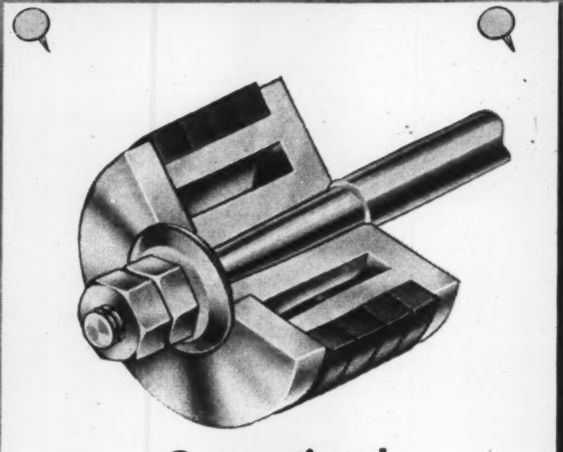
ACCURATE · VARIABLE

Reeves Speed Control

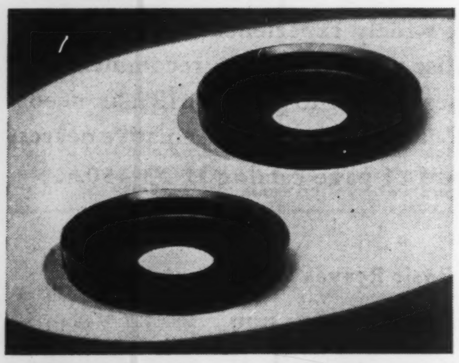
GIVES THE RIGHT SPEED FOR EVERY JOB!

TWO WAYS TO PACK PISTONS:


Johns-Manville Moulded Packing Cups


Conventional type piston packing

—Which does the better job?



RECOMMENDED FOR PISTONS IN

- Reciprocating Pumps
- Hydraulic Lifts
- Hydraulic Jacks
- Hydraulic Presses
- Drilling & Boring Machinery
- Air Brake Cylinders
- Compressors
- Governors
- Power Shovels
- Grease Guns
- Air Chucks
- Grinders
- Valves (hydraulic or air operated)

BOTH THE PACKINGS shown on these two pistons will do a job. But the piston on the left will operate more efficiently and more economically because it is designed for Johns-Manville Moulded Packing Cups.

Design engineers are expressing a growing preference for these custom-made cups for two reasons: (1) They practically eliminate slippage past the piston. (2) They require less frequent replacement in service.

Johns-Manville Moulded Packing Cups operate like this: Each cup is designed with a flexible lip, which, under discharge pressure, forms a tight seal. On the reverse stroke, the lip relaxes. This action, plus their precise fit, lowers friction and wear on liners and reduces the amount of power required for the stroke.

Wherever Johns-Manville Packing Cups have been used—against water, oil, air, and other liquids and gases—they have proved to be a good investment by increasing efficiency and lowering operating costs. If you design or manufacture any of the equipment listed at left, write for further information about these custom-made cups. Address Johns-Manville, Box 290, New York 16, N. Y.

Johns-Manville *Packings and Gaskets*

As the white outline indicates, a standard unit of much greater frame size would be required to do the work of Speedaire.

SPEEDAIRE made it possible

THE layout of this paper box plant allows little clearance for the Wood Screen drive. As this photo shows, motor and speed reducer are mounted on a short, narrow ledge. There is not enough room for a standard drive. Only a compact, powerful Speedaire would go in the limited space available.

Speedaire not only saved space; it saved weight and saved money. A standard worm-gear unit to handle the load would have cost 19% more, weighed 30% more and required 61.4% more space.

Speedaire is Cleveland's new fan-cooled worm-gear speed reducer. Because it is fan-cooled, Speedaire will do more work—will deliver up to *double the horsepower* of standard worm units of equal frame size, at usual motor speeds. It can be installed economically on many applications where other types have been used heretofore—giving you the advantage of a compact right-angle drive. Speedaire gives the same long, trouble-free service characteristic of all Clevelands.

For full description, send for Catalog 300. The Cleveland Worm & Gear Co., 3265 East 80th St., Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

CLEVELAND
Worm Gear
Speed Reducers

Quick Casting Service

(coast to coast)

Coast to coast . . . you'll find modern Alcoa foundries. Each provides the latest production machinery for economy. Each employs foundry men with 20 and 30 years of aluminum experience. Molders and coremakers who guarantee you quality castings. Each draws from the extensive knowledge gained from Alcoa's 61 years of light metal experience. These are the exclusive advantages that make Alcoa your *best* source for the *best* sand and permanent-mold castings in aluminum.

Your local Alcoa sales office offers prompt service. ALUMINUM COMPANY OF AMERICA, 675-H Gulf Building, Pittsburgh 19, Penna.

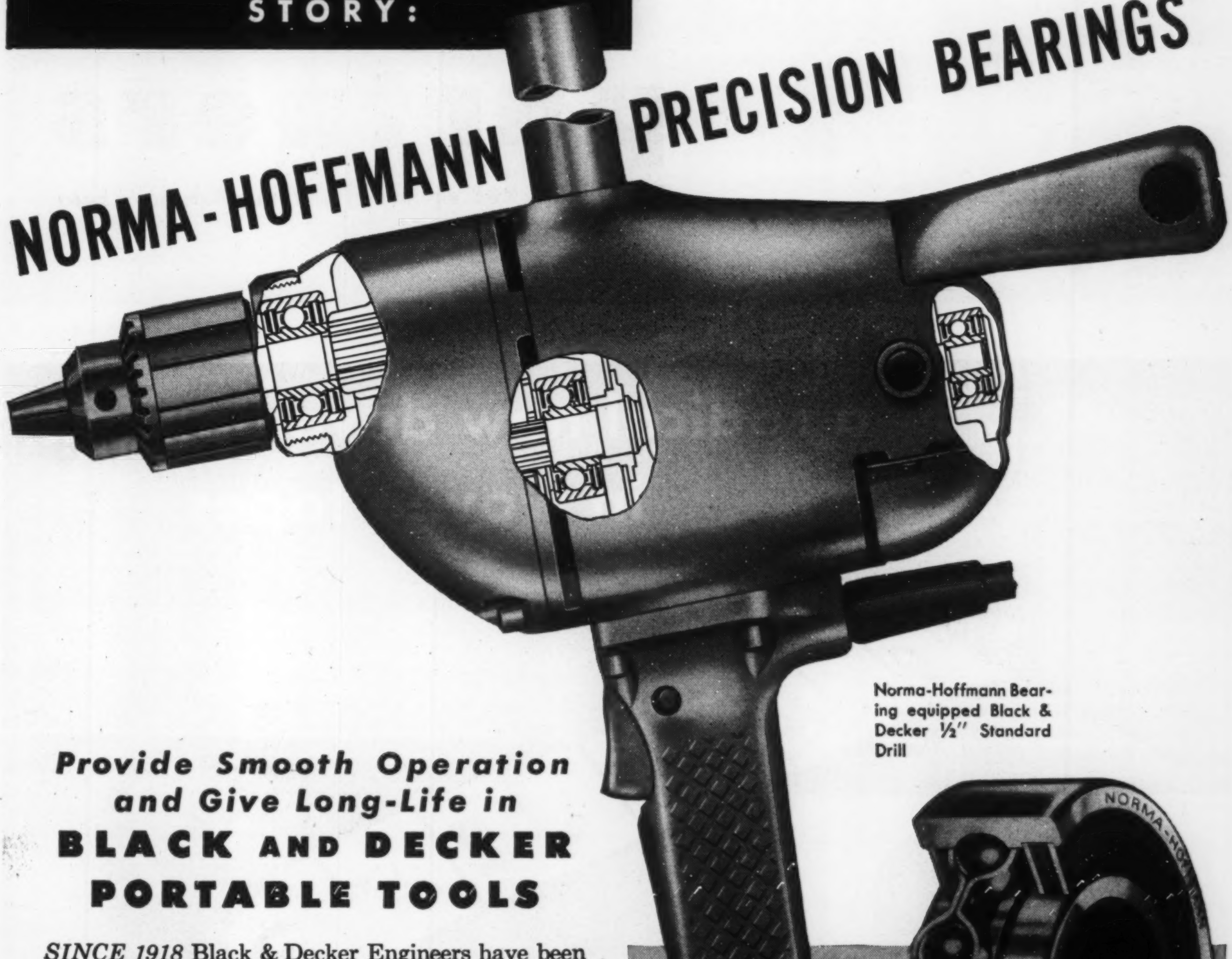
MISSING A CHANCE TO IMPROVE YOUR PRODUCT? Alcoa Aluminum castings offer high strength, half the weight, easy machining, corrosion resistance.

ALUMINUM CASTINGS *by* **ALCOA**

INGOT • SHEET & PLATE • SHAPES, ROLLED & EXTRUDED • WIRE • ROD • BAR • TUBING • PIPE • SAND, DIE & PERMANENT MOLD CASTINGS • FORGINGS • IMPACT EXTRUSIONS
ELECTRICAL CONDUCTORS • SCREW MACHINE PRODUCTS • FABRICATED PRODUCTS • FASTENERS • FOIL • ALUMINUM PIGMENTS • MAGNESIUM PRODUCTS

ANOTHER "Preference-Proof" STORY:

NORMA-HOFFMANN PRECISION BEARINGS



Norma-Hoffmann Bearing equipped Black & Decker ½" Standard Drill

Provide Smooth Operation and Give Long-Life in
BLACK AND DECKER PORTABLE TOOLS

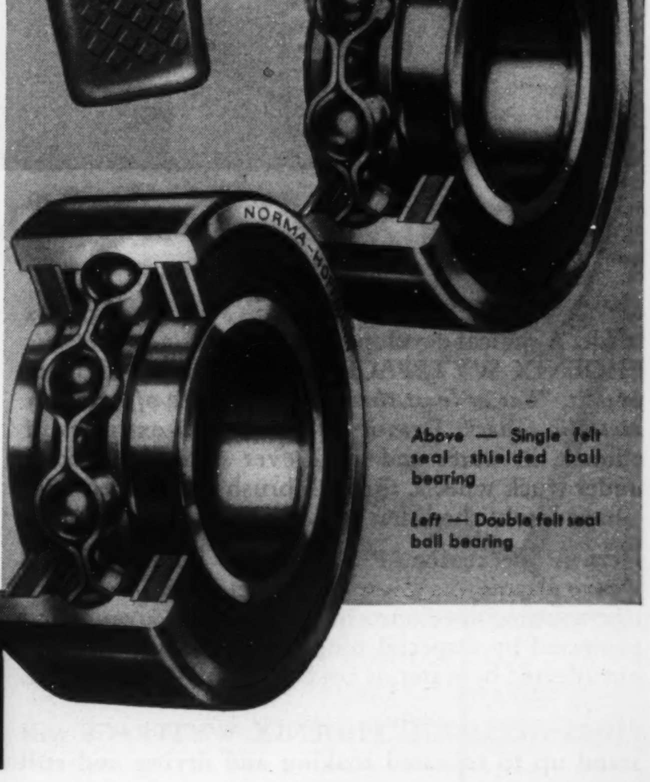
SINCE 1918 Black & Decker Engineers have been using Norma-Hoffmann Precision Bearings in many of their portable tools for their exceptional long-lived, dependable performance.

A typical application example is the "B & D" ½" Standard Drill, illustrated, in which three Norma-Hoffmann Bearings are used. Commutator and fan end of the armature rotate on single felt seal shielded bearings...and the chuck spindle is carried on a double felt sealed bearing. Armature speed is 16,800 RPM . . . full load spindle speed is 275 RPM.

Manufacturers of other equipment from electric motors to machine tools, can also benefit with the use of Norma-Hoffmann Precision Ball and Roller Bearings. Their dependability, friction-free smoothness and quietness of operation improve design and performance of products wherever they are used. A wide range of types and sizes makes selection easy.

Norma-Hoffmann Field Engineers will gladly help you with your bearing problems. Write for their assistance.

NORMA-HOFFMANN BEARINGS CORPORATION
STAMFORD, CONNECTICUT



Above — Single felt seal shielded ball bearing

Left — Double felt seal ball bearing

NORMA-HOFFMANN
Precision **BEARINGS**
BALL • ROLLER • THRUST

K+E partners

For 82 years K&E equipment and materials have been

a radical new development in woven tapes

PHOENIX WYTEFACE Non-metallic Woven Tapes

Trade Mark U. S. Pat. 2,321,920

OVER 3 TIMES LONGER WEAR. An enormous stride. A radical development. The new *non-metallic* PHOENIX WYTEFACE, as one highway engineer puts it, *"has at least three times the life of ordinary metallic tapes"*. Drastic field tests—in extremes of climate, in water and mud, over stones and rocks, under truck wheels, through brush and barbed wire—have established that fact.

Here is the reason. PHOENIX WYTEFACE is a weave of amazingly strong synthetic yarns—a scientific wartime development—completely covered and protected by a special tough plastic coating that is not affected by water, is not brittle and will not flake.

MORE ACCURATE. PHOENIX WYTEFACE will stand up to repeated soaking and drying and still maintain a dimensional stability substantially higher than that of ordinary so-called "metallic" tapes.

HIGHER DIELECTRIC CONSTANT. PHOENIX WYTEFACE Woven Tapes are entirely non-metallic—a feature that is important to Power and Utility Companies and to anyone working near high tension circuits.

EASY TO READ AND CLEAN. The clear black and red markings on the white background are easy to read. The surface is easily wiped clean.

Ask your K&E Distributor or any K&E Branch to show you the new PHOENIX WYTEFACE non-metallic Woven Tape, or write on your letterhead for a sample length to Keuffel & Esser Co., Hoboken, N. J.

[illegible]

in creating . . .

partners of the draftsman, the engineer and the scientist in shaping the modern world

K&E HAND LEVELS . . . VERSATILE, RUGGED, PRECISION-MADE

K&E Hand Levels are versatile, useful instruments that fill a variety of needs—to lay out rough grades, establish contour lines, take cross sections, run lines of levels, or carry out any leveling work when speed and convenience come first.

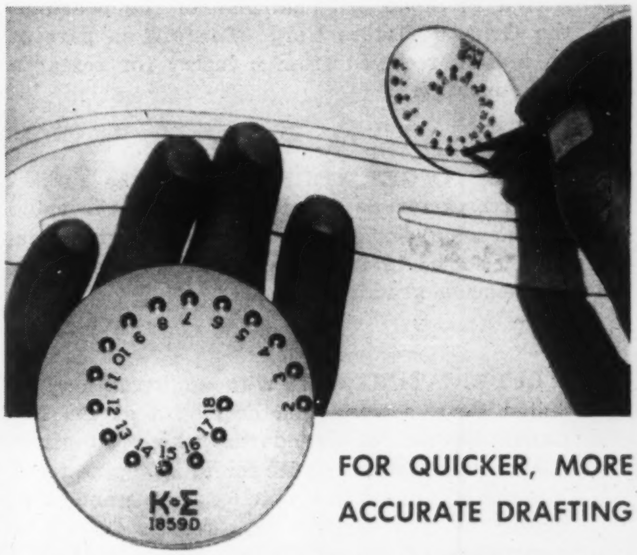
Though designed to stand up to rough usage without need for constant adjusting, K&E Hand Levels are made to precision standards and are simple in design.

The hand level with the circular tube in the picture is the No. N5702, 6 inches long. It is also available with stadia lines for measuring distances (No. N5702D).

The square tubed hand level, No. 5704, 6¼ inches long, has a simple device for right angle sighting as well.

Ask your K&E Distributor or Branch to show you these K&E Hand Levels, or write Keuffel & Esser Co., Hoboken, N. J. for the K&E Hand Level booklet.

KEUFFEL & ESSER CO.
5704



FOR QUICKER, MORE ACCURATE DRAFTING

The K&E PARALLEL LINE TRACER is one of many time-saving K&E Draftsmen's Tools. With this handy device, lines can be drawn parallel to the edge of any straight or curved guide at various distances from it. Ideal for graph plotting, mapping, railroad work, airplane or ship design.

Ask your K&E Distributor or Branch to let you see the booklet "K&E Templates and other Drafting Tools", or write Keuffel & Esser Co., Hoboken, N. J. for a copy.

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Drafting, Reproduction,
Surveying Equipment
and Materials.
Slide Rules,
Measuring Tapes.

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Topics

METAL PROCESSING building will be constructed at Massachusetts Institute of Technology as a result of a gift of $1,000,000 from Alfred P. Sloan Jr., chairman of the board of the General Motors Corp. The gift is part of $5 million received from industry for research and education.

HOW TO GET YOUR JOB was the subject of a recent two-day conference at the Cleveland Engineering Society as a practical guide designed to be immediately useful to the young engineering graduate.

LUBRICATING OILS with additives may be tested by a new method developed at the National Bureau of Standards which simulates the characteristic deposits found in engine tests. The method requires simple apparatus and eliminates the fuel variable that results from contamination of the oil by engine fuel. Deposit from a thin film of oil flowing over a heated strip of steel provides a sensitive method of rating.

MAGNETIC RECORDING for sound tracks on movie films will be available for the amateur through an agreement between Eastman Kodak Co. and Armour Research Foundation. The sound track can be edited at will simply by erasing the original and replacing it with whatever script is desired, a feature impossible with optical sound tracks. Also sound effects may be dubbed in as desired.

ALUMINUM is employed for over 90 per cent of the new Twin Coach bus, resulting in a 41-passenger coach which weighs 13,500 pounds compared with 19,000 pounds for steel construction. Aluminum castings are used extensively in the suspension system.

LIQUID IMPACT METHOD of piercing and blanking operations on silicon sheet steel has been developed experimentally by General Electric engineers at Schenectady. The method substitutes a column of oil for the punch which wears out rapidly on this type of steel. The oil may be channeled back for reuse. Dies may be soft, unhardened steel which cannot be used with the conventional punch. For each size and thickness of steel it is necessary to calculate the particular impulse necessary for satisfactory punching.

PHOTOGRAPHIC VIEWFINDER which presents a clear, erect and unreversed image has been developed at the Air Materiel Command headquarters at Dayton. Known as the type B-2 viewfinder it will be useful for navigational purposes and for aerial photography. Two integrated optical systems, using the same screen, give either a broad field of image below and ahead of the aircraft or a narrower field with larger scale image covering terrain directly below the craft.

PRICE POLICIES of industry prompted the statement from W. L. Schneider, former president of AGMA, "We have no quarrel with those who sell for less; they should know what their products are worth."

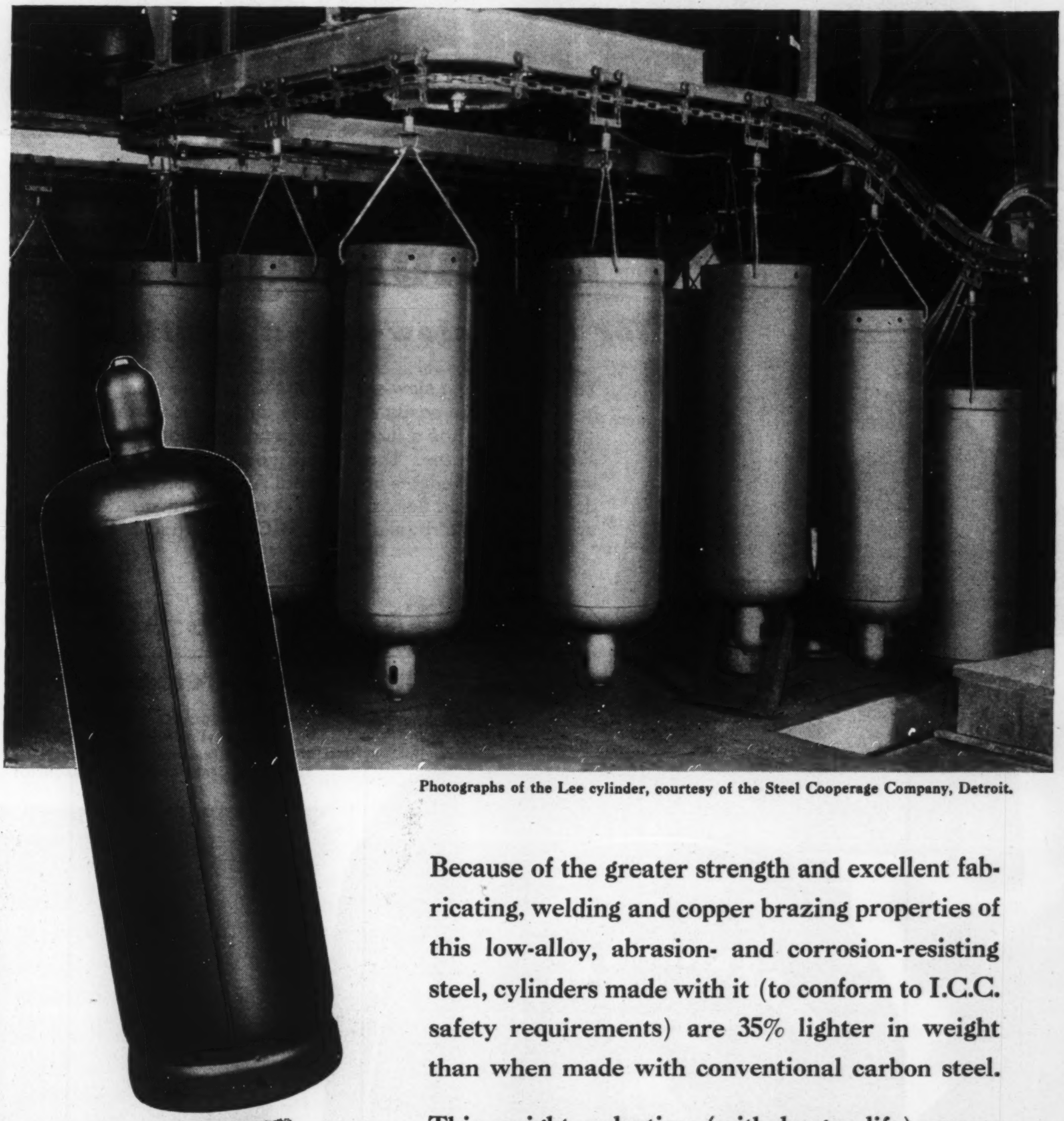
NOISE made by most public transportation vehicles is more than the noise frequency and decibel levels normally accepted by the human ear as psychologically pleasing, according to a survey in Chicago made by Armour Research Foundation.

BRAZING ALUMINUM to steel has been developed as a commercial process by Salkover Metal Processing. Method is simple, low in cost and is suitable for brazing aluminum fins on steel cylinders as well as for fabricating assemblies in which the special properties of steel inserts are combined with the light weight of aluminum.

ENGINEERS AND SCIENTISTS are needed by the Government for work in the fields of their greatest competence. A new file in Washington is being created to contain 100,000 filled-in questionnaires for this purpose.

N-A-X HIGH-TENSILE STEEL in L.P.G. Cylinders

means light weight with added safety and durability



Photographs of the Lee cylinder, courtesy of the Steel Cooperage Company, Detroit.

Because of the greater strength and excellent fabricating, welding and copper brazing properties of this low-alloy, abrasion- and corrosion-resisting steel, cylinders made with it (to conform to I.C.C. safety requirements) are 35% lighter in weight than when made with conventional carbon steel.

This weight reduction (with longer life) means greatly reduced shipping and handling costs . . . and over-all savings to consumers.

MAKE A TON OF SHEET STEEL GO FARTHER

Specify—

N·A·X

HIGH-TENSILE STEEL

GREAT LAKES STEEL CORPORATION

N-A-X ALLOY DIVISION • DETROIT 18, MICHIGAN
UNIT OF NATIONAL STEEL CORPORATION

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Less weight . . . Less space

the motorgear

for more slow-speed applications

You've wanted a slow-speed unit that is more compact, lighter in weight, more easily adaptable to a wider variety of applications—that has a modern, dependable motor with simpler, sturdier gear train. That's what you get in the Motorgear—the combined benefits of the Axial Air Gap Motor and modern double reduction helical gears. Available in standard ratios, up to 10 hp. Fairbanks, Morse & Co., Chicago 5, Ill.

FAIRBANKS-MORSE

A name worth remembering

DIESEL LOCOMOTIVES • DIESEL ENGINES
PUMPS • SCALES • MOTORS • GENERATORS
STOKERS • RAILROAD MOTOR CARS and
STANDPIPES • FARM EQUIPMENT • MAGNETOS

AUGUST, 1949

MACHINE DESIGN
A PENTON PUBLICATION

Extending the Engineer's Horizon

ABSORPTION in purely technical problems has caused many an able machine designer to overlook other equally important phases of professional activity. If he is to progress personally and professionally it is imperative that he extend his horizon beyond the confines of a particular engineering department.

Competent engineers and engineering executives do not just happen—they are the result of wide experience and broad contacts. Recognizing this, forward-looking companies are taking positive steps to broaden the experience and develop the latent abilities of their engineers and designers, not only in engineering, but also in the direction of management.

The most important of these steps is the encouraging of their engineers to travel for the company on engineering problems, to attend expositions and conventions, and to participate in the activities of national engineering societies by serving on committees and by presenting technical papers at their meetings. Engineering society activities offer excellent opportunities to acquire valuable practice in working with people, in learning how to plan, how to organize, how to put across ideas. Management has much to gain by urging engineers to join and become active in engineering societies, and money spent in paying their expenses is a sound investment in the future.

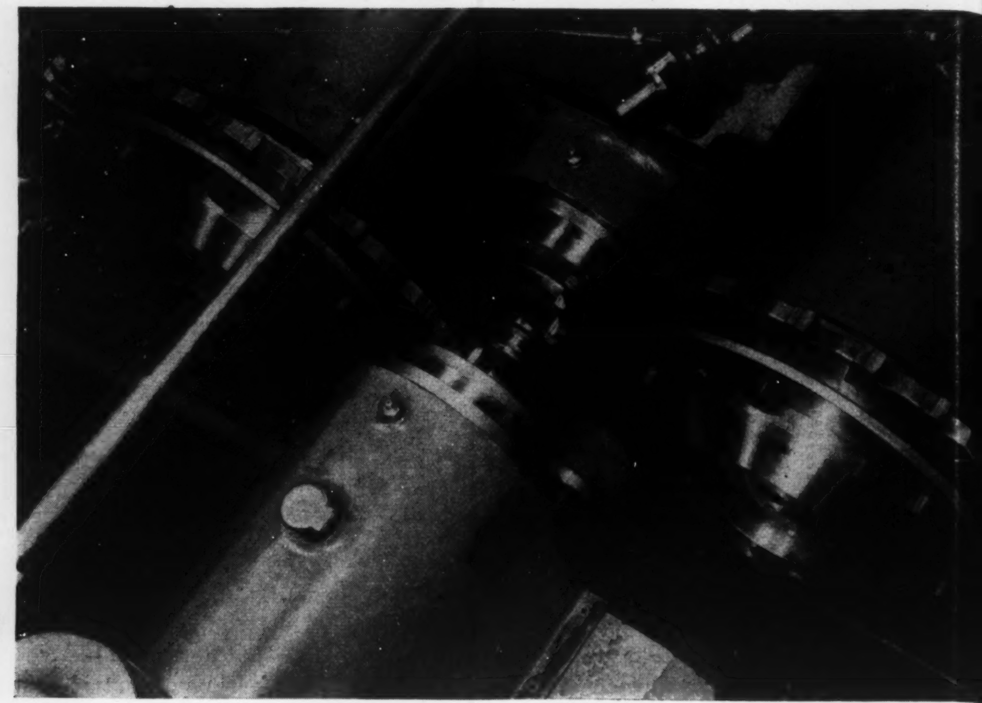
Broader contacts give the engineer an opportunity to orient his abilities in the vast field of engineering—to find that niche within which he can function most effectively. They also enhance his overall understanding of engineering as a business and as a profession. Thus, there is established within him a keener appreciation of his professional stature and a vastly improved self confidence. Such engineers are urgently needed to fill top positions in the management of machinery manufacturing organizations.

An engineer cannot even keep pace with his profession if his life is lived out of contact with it. To become a better designer as well as a leader in his profession, he needs to be relieved at times of humdrum routine in order to view in proper perspective the broad vista of contemporary knowledge and thinking.

Colin Carmichael

EDITOR

Fig. 1—Right—View of a turn milling operation on a two-throw outboard engine crankshaft



By Roger W. Bolz
Associate Editor, Machine Design

Turn Miller

A new machine for a new process

EXTREMELY versatile, the process of milling has branched out in many directions over the years. One of these many branches has been generally termed turn milling, and encompasses the generation of circular or cylindrical surfaces with a rotating milling cutter, *Fig.* 1. Inasmuch as the milling cutter removes material from a rotating workpiece by characteristic small bites as against continuous chips normal to turning, the milling method has often been found extremely useful in finishing work-hardening materials.

The newest application of turn milling, developed by L. E. Godfriaux of the Gisholt Machine Co., has

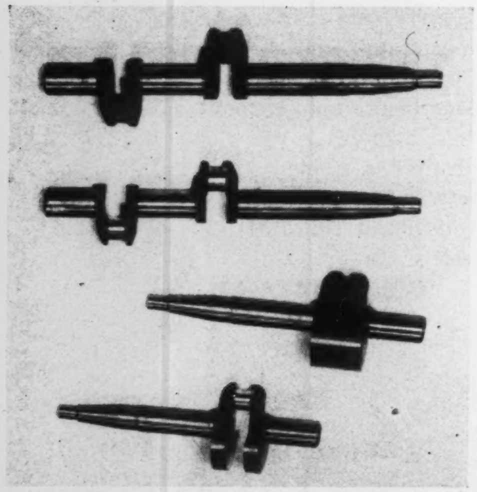
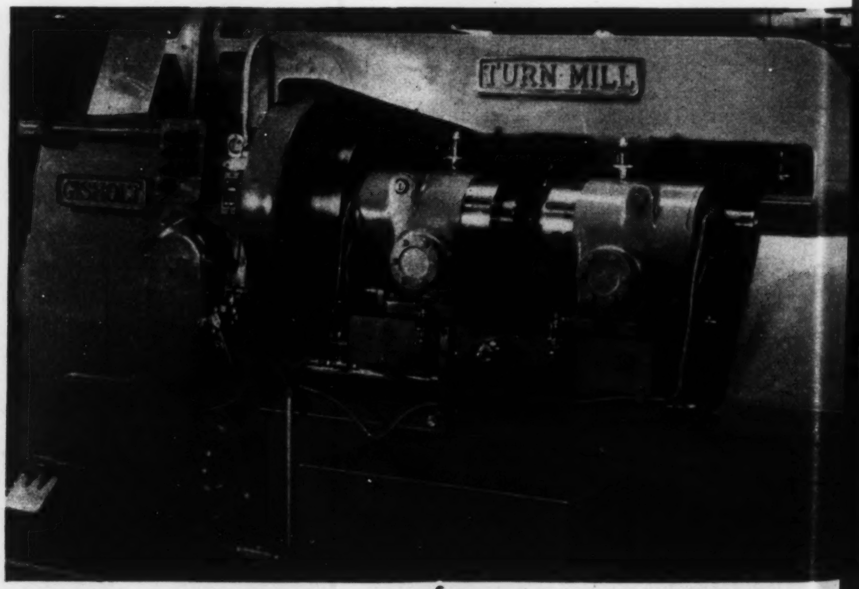


Fig. 2—Above—Two types of small crankshaft showing fully forged and partially forged designs finished and unfinished



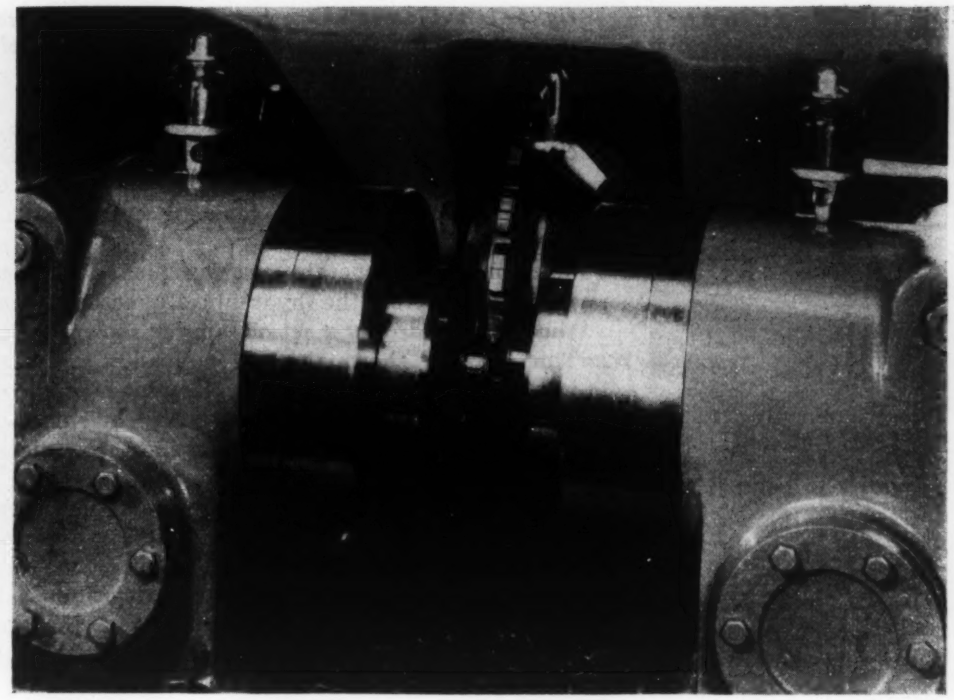


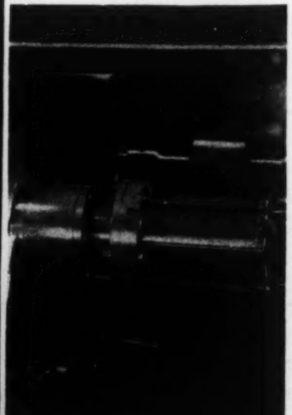
Fig. 4—Left—View of turn miller showing the cutter and crank in working positions

been to the machining of crankshafts and similar parts where cheeking as well as turning is necessary. A crankshaft presents a difficult machining problem owing to the extreme character of the interrupted cheeking or facing cut. For turn milling, however, the problem is simple; the cutting can be substantially the same for the entire operation. It makes little difference whether the crank is fully or partially forged through the cheeks, *Fig.* 2.

In turn milling crankshafts, the throws can be turned either on the throw centerline or on the crank centerline. The simplest Gisholt machine, developed around the Simplematic lathe and adapted to smaller production, uses a single milling cutter and mills one throw at a time, *Fig.* 3. For small outboard-engine and similar cranks, the work heads contain special fixtures which clamp the work so as to permit rotation of the crank about the pin centerline. After milling one pin the crank can be removed and reversed to finish the second pin.

In the cycle of operation, the cutter mills through the cheeks to preset depth whereupon the work holding heads begin to revolve. After completing one revolution the heads stop and the crank withdraws, *Fig.* 4. The characteristic chips produced can be seen in *Fig.* 4 also. A binegative rake is used on the cutter blades and the action is such as to deliberately

Fig. 3—Left Below—Simplest turn miller, with a single cutter, which turn-mills about the throw centerline



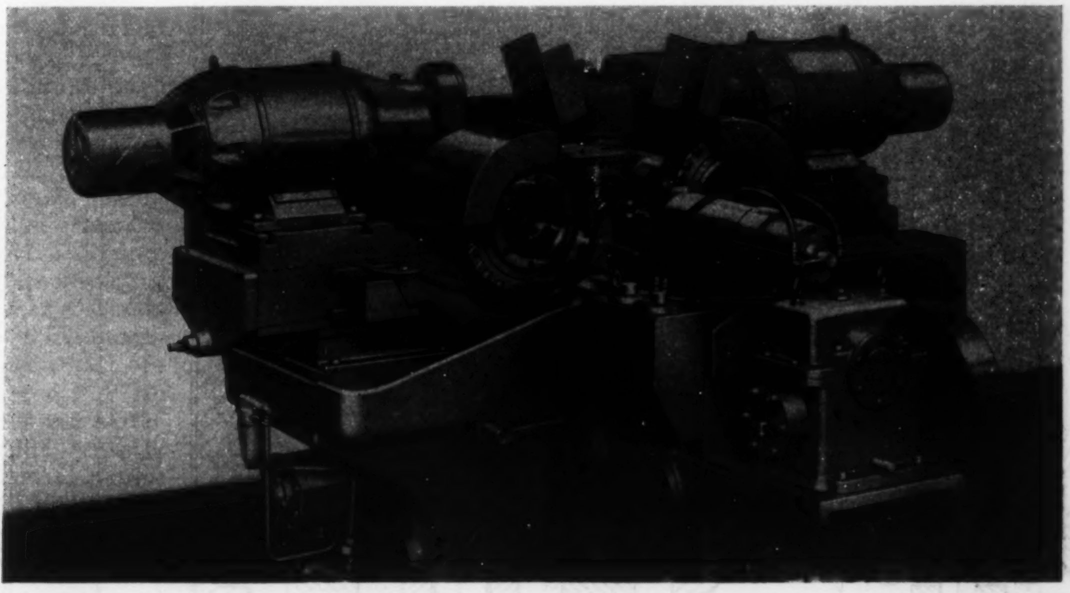


Fig. 5—Bottom Right—First model of the larger automatic machines which mill four crank throws simultaneously by following them about their orbits

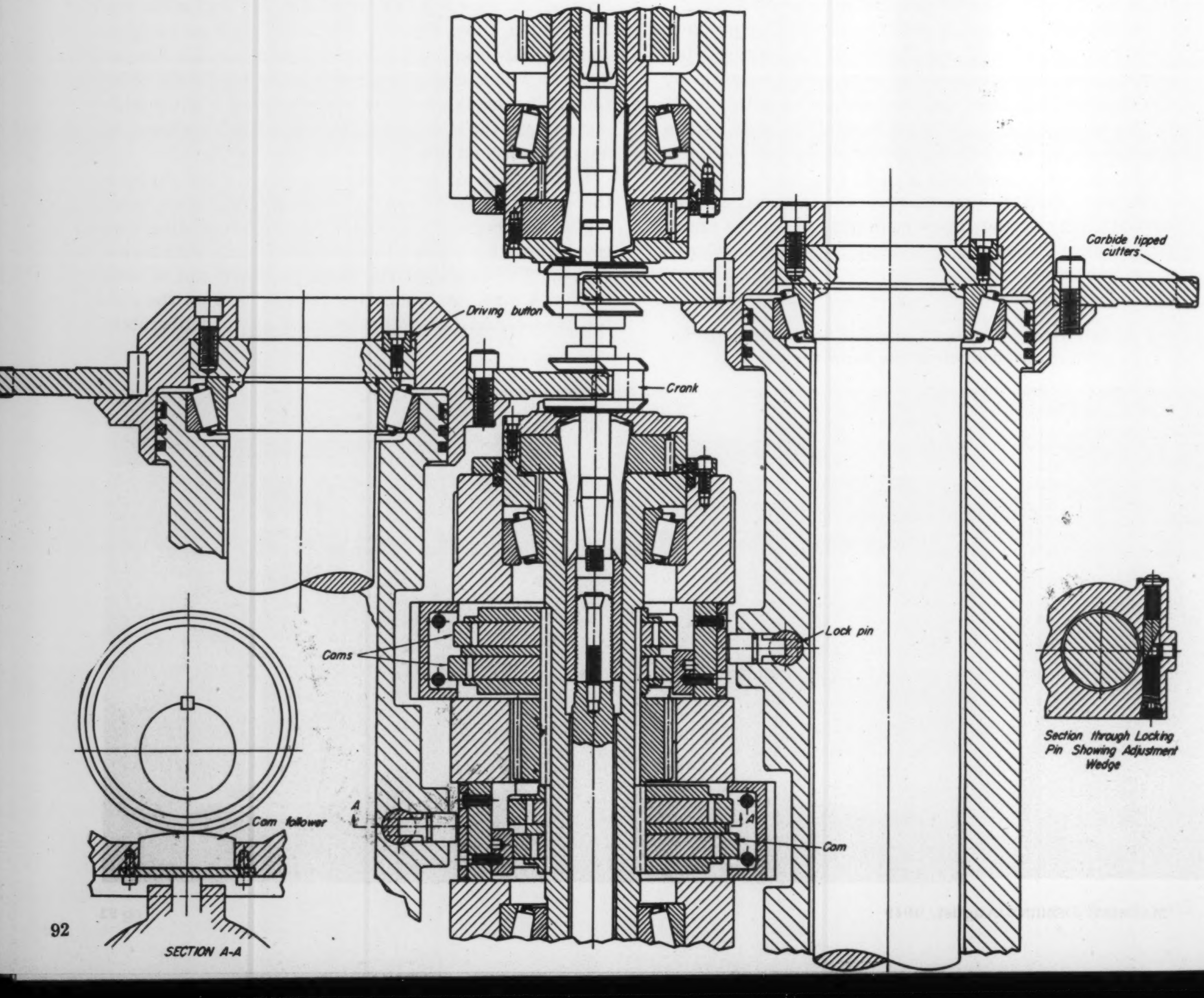
Fig. 6—Left—Closeup of the machine in Fig. 5 with rough and finished cranks shown resting on top of the control box

bend the chips in the middle in order to permit freeing from the cut quickly.

With larger special machines, *Fig.* 5, the cycle is somewhat different in that the cutters advance and withdraw in operation and, also, the pins are turn milled while rotating about the crankshaft centerline. In this machine four throws are all milled simultaneously in 0.6-minute, floor-to-floor, *Fig.* 6. Two-throw or single-throw cranks can also be handled in the machine with the same time cycle. With these machines the cutters feed to depth opposite the cheeks and on reaching preset depth the crank is rotated one revolution to complete the machining of the pins and the cheeks; the finishing cut through the cheeks removes any close-in.

In order to generate circular pins during their planetary travel, the hydraulically actuated cutter slides are guided by a set of cams as shown in *Fig.* 7. This drawing shows the cutter spindles and mountings, the head and tailstock clamping arrangement, and the cam setup for a two-cutter machine. The cams are made much larger than the throw diameter primarily for practical purposes and accuracy, and rotate on suitable bearings. To avoid the necessity for a specially generated cam contour, the cam-follower face is ground to a radius complementary to that of the cam and thus maintains a constant cutter-spindle-to-work-center dimension over the entire planetary travel of the eccentric cams. A locking

Fig. 7—Below—Cross section drawing of the cutter spindles and workheads showing the control cams. Units with as many as five cams have been made



Section through Locking Pin Showing Adjustment Wedge

wedge button in the cutter spindle permits minute adjustment of the cam follower position to compensate for cutter wear. Two sets of cams are shown in *Fig.* 7. By moving the cam follower to the proper cam, pins of varying throws and diameters can be generated.

The work drive on the original machine, as shown in *Fig.* 5, was through a motor-driven speed reducer. To permit simpler control and greater flexibility in operation, this design was changed to one with tandem hydraulic motors. These drive through a pair of 60-to-1 worm and gear arrangements having backlash eliminating features as shown in *Fig.* 8. The dual worm gears are interconnected by means of spur gears which can be adjusted to remove all play.

Because the headstock and tailstock must be synchronized — the entire driving engagement with the workpiece is by hydraulic collet clamping—the hydraulic motors are connected mechanically by a sliding bevel gear drive, *Fig.* 9.

Hydraulic Drive

The tailstock is brought up to the work by hydraulic power and when it reaches the positive-stop position, a pilot control valve is turned to close the work holding collets. This circuit also actuates the tailstock locking device. The machine is then run through its cycle to complete the crank milling. Actuation of the start pushbutton directs 350-psi oil pressure to the cutter slides and after a fast approach the cylinder throttles meter the exhaust oil through speed-control valves during the feed-in cut until the slides contact the size-control cams. At this point a limit switch starts the oil motor drives to the work heads for rotating the crankshaft. The exact instant at which the speed-control valves are dropped out of action is adjustable by means of the dumping valves on the slides which are actuated by a cam plate, *Fig.* 10.

During the infeed of the cutter slides the full hydraulic pressure is maintained by the regulating valve. After the cam has turned 180 degrees, the slide infeed has been completed and the direction

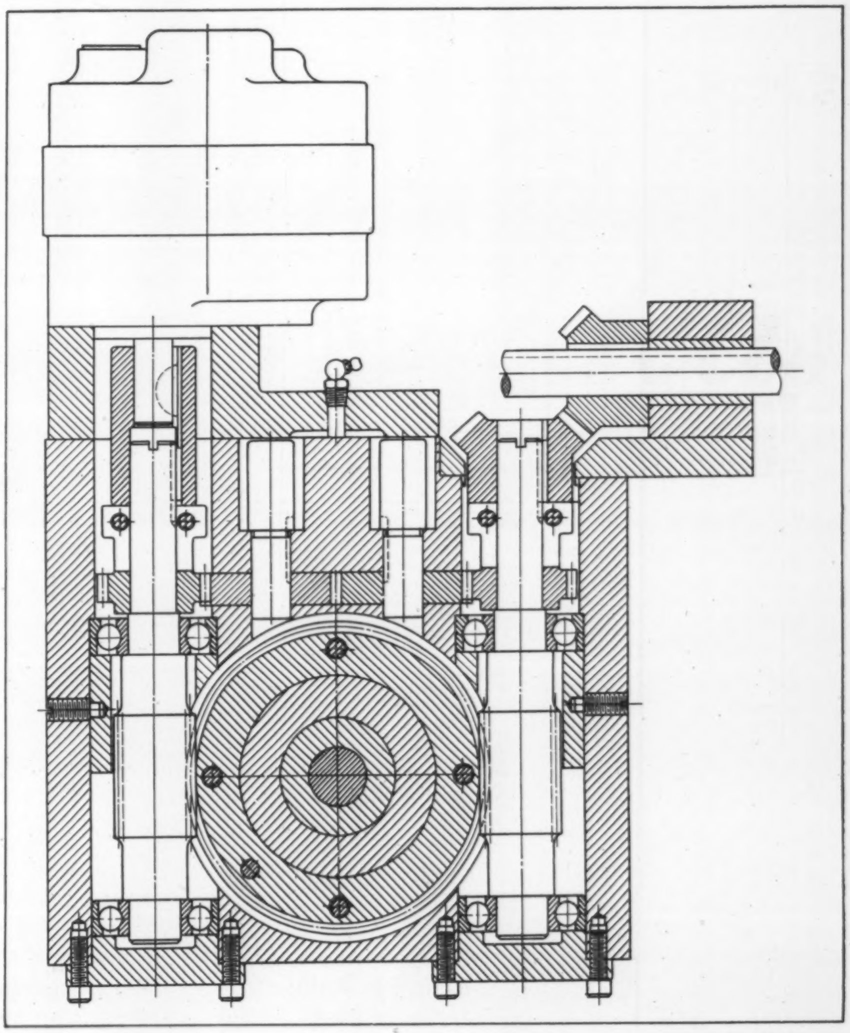
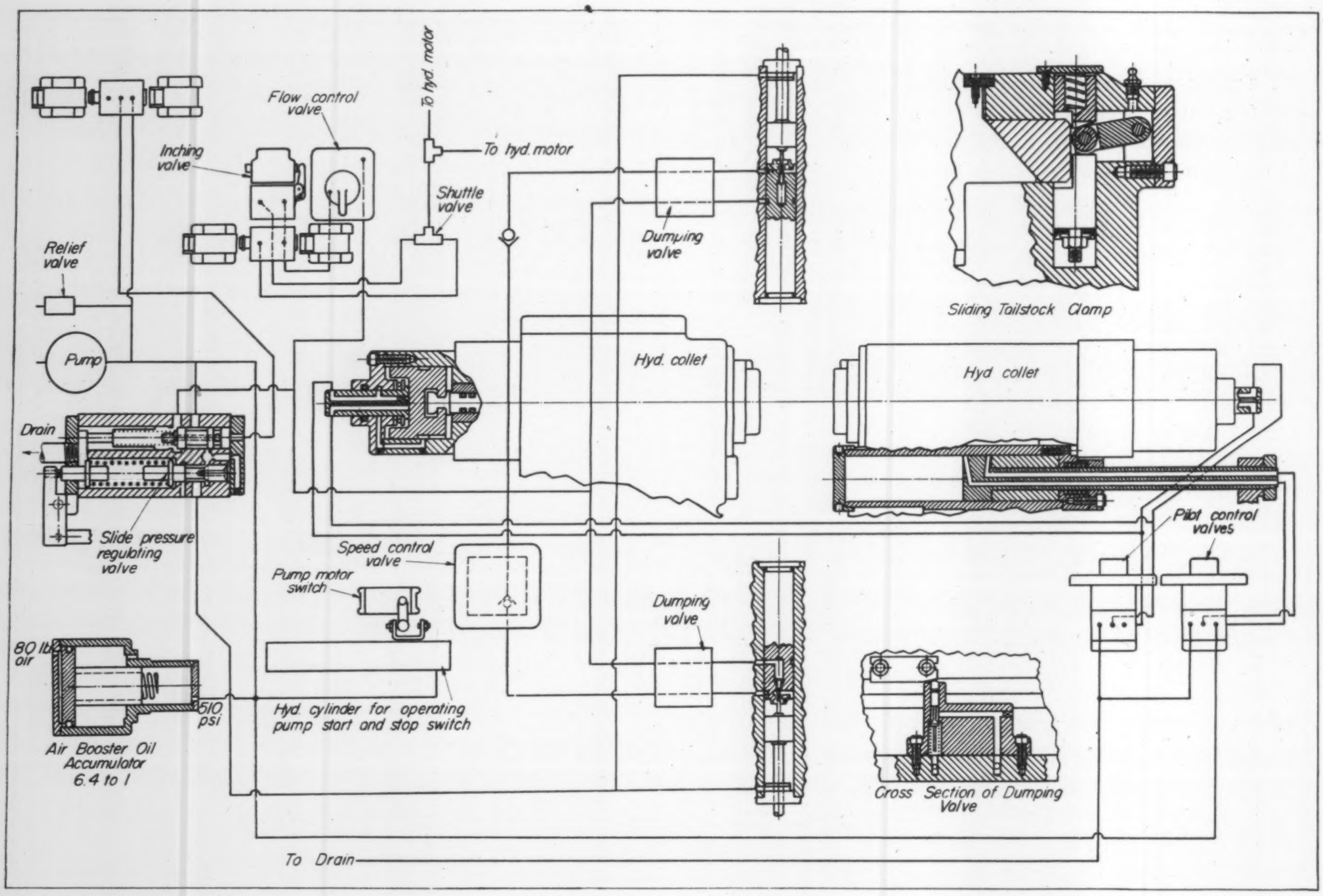


Fig. 8—Above—Cross section of the work drive mechanism. Interlocking gearing permits removal of all drive gear backlash

Fig. 9—Below—View of a two-cutter machine showing the hydraulic head and tailstock drive units connected together mechanically by the shaft across the top


Flow control valve
To hyd. motor
To hyd. motor
Inching valve
Shuttle valve
Relief valve
Dumping valve
Sliding Tailstock Clamp
Pump
Hyd. collet
Hyd collet
Drain
Slide pressure regulating valve
Speed control valve
Pump motor switch
Pilot control valves
Dumping valve
80 lb air
510 psi
Hyd. cylinder for operating pump start and stop switch
Air Booster Oil Accumulator 6.4 to 1
Cross Section of Dumping Valve
To Drain

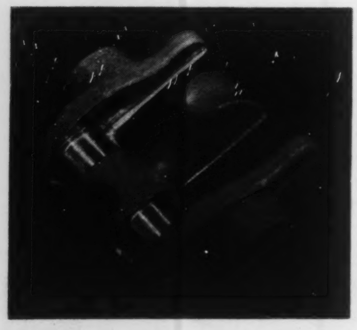


Fig. 10—Above—Schematic layout of the machine hydraulic circuit showing the special pressure regulating valve for the slide and the accumulator control

Fig. 11—Left—Cross sections of rough and finished automotive crank

of the slide movement is then reversed. During the reversed direction of the slide movement a reduced pressure is maintained while the cams both guide and force the slides back. At completion of the 360 degrees of cam movement, the slides are automatically returned to start position by the same control valve.

To insure that positive pressure holds the cutter slides against the control cams during their orbital traverse, a special regulating valve arrangement has been worked out, *Fig.* 10. Driven from the work spindles is a control cam which varies the effective spring preload on this regulating valve. Thus, as the cams force the slide to retract, the oil pressure behind the right end of the valve plunger slowly moves the plunger to the left, cutting off the volume and exhausting oil by an amount sufficient to maintain a substantially uniform back pressure of 100 to 125 psi on the slide.

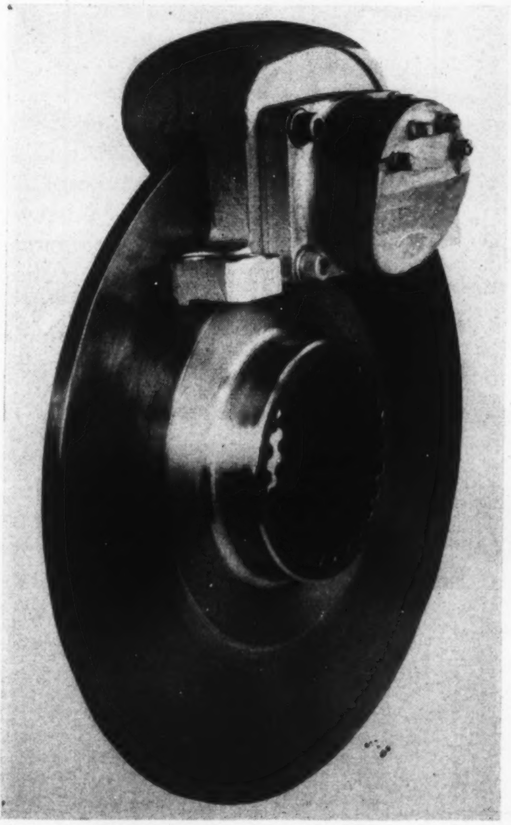
An air-booster oil accumulator is utilized to maintain a uniform hydraulic pressure and obviate continuous pump duty. In lieu of a pressure switch for cutting the pump in and out, a hydraulic cylinder start-and-stop control is employed, *Fig.* 10. Working against spring loading, the cylinder arrangement permits adjustment for the most practical pressure range. A feature of the hydraulic components can be noted on the various drawings—all exhaust oil is routed from the top of each component wherever possible to permit ready release of entrained air.

ACCURACY: In production, accuracy depends somewhat upon the strength and rigidity of the crankshaft itself. With small, light outboard-engine cranks a tolerance of plus or minus 0.004-inch can be held on plane, parallelism and out-of-roundness, inclusive. With heavier automotive cranks width can be held to plus or minus 0.002-inch, spacing of throws to plus or minus 0.002-inch, throw position and plane to plus or minus 0.005-inch, and out-of-roundness to plus or minus 0.004-inch. These tolerances are sufficiently close to permit the consideration of automatic gang grinding in production should such be desirable.

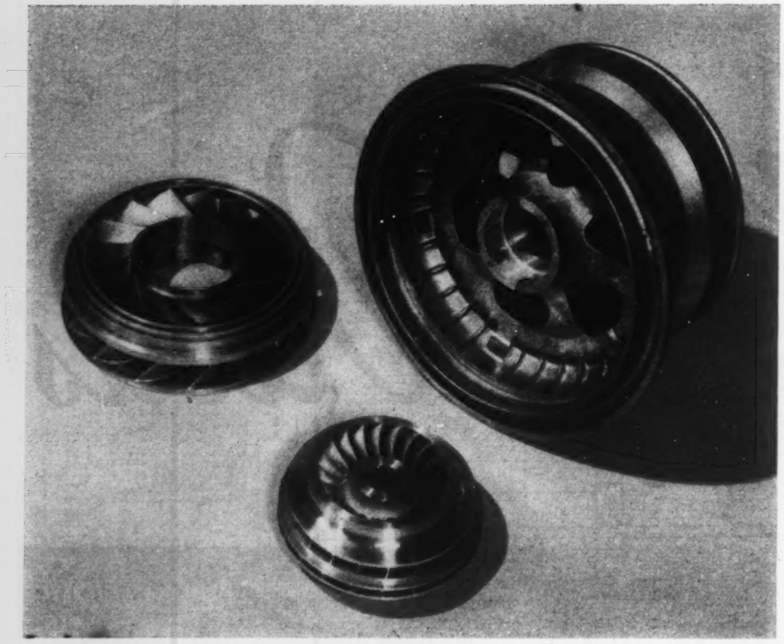
FINISH: As can be seen from an appraisal of the cutting action in turn milling, the resulting finish is a series of longitudinal faces about the circumference of the pin, *Fig.* 11. Each facet represents the work feed per tooth of the cutter. The radial difference between the peaks and flats of the surface actually measures about 0.0005-inch. These longitudinal facets actually improve grinding conditions unlike circumferential markings which often create detrimental wear effects on the grinding wheel.

Scanning the field for Ideas

SINGLE-DISK brake, below, adapted for industrial use from an airplane type brake is shown at right installed on a mine shuttle car. It has reduced maintenance by more than one-half in an experimental test program conducted by Goodyear engineers in co-operation with Joy Mfg. Co. A nonself-energizing brake, it has a straight line torque curve throughout the braking range and gives equal torque in both directions. Construction is simple and it is self-adjusting over the life of the lining.



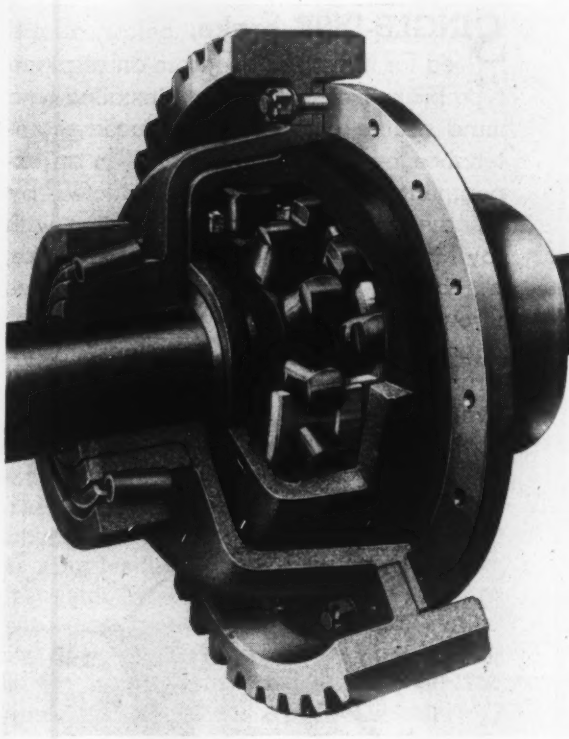
Plaster-mold castings of nonferrous alloys may be made on a mass production basis with such control of critical dimensions and surfaces that machining and balancing are almost totally eliminated. Versitility of the method is illustrated by the three pieces shown at top of next page as cast by the foundries of the Eclipse-Pioneer division of Bendix Aviation Corp. Upper left is a turbine for a torque converter. Upper right is a 10-inch airplane landing wheel so accurately cast that only the hub requires machining. The process permitted thinner, lighter walls, reinforced by internal ribbing, effecting a two-pound saving in weight over other methods. In the foreground is a 6-inch, 2-stage, high-speed,

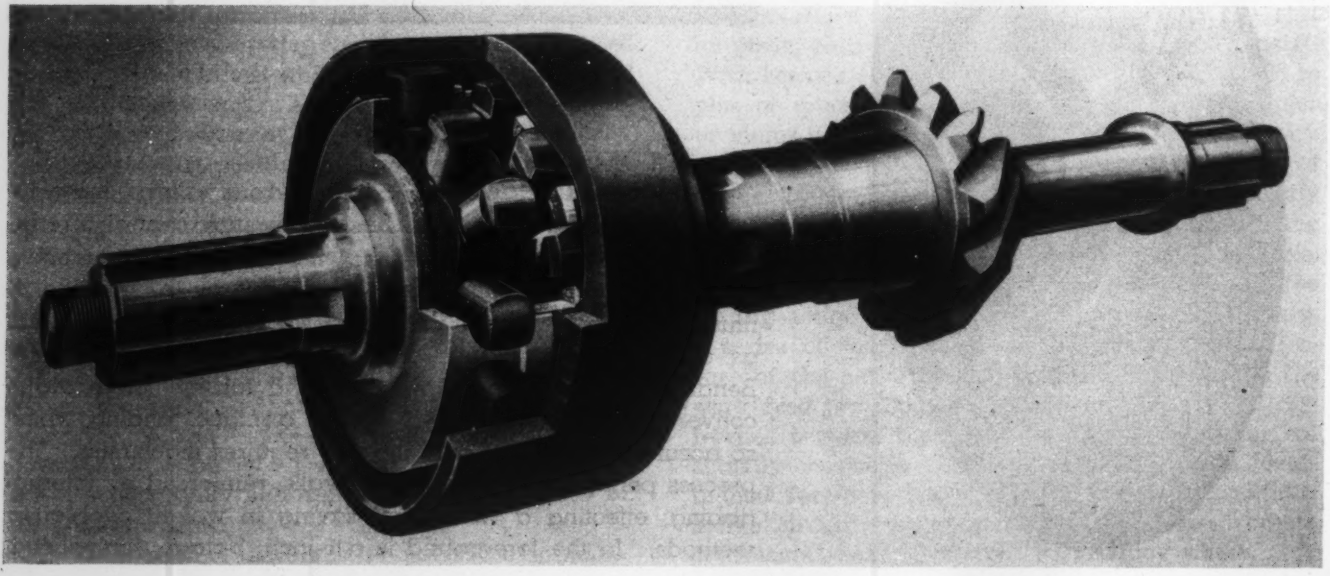


shrouded impeller with specifications calling for critical balance and satin-smooth inner surfaces. Cast in one piece, the impeller has a web of vanes which were kept within tolerances of 0.005-inch while the entire unit has sufficient strength to withstand peripheral speeds up to 1500 feet per second.

Differential action is obtained with the unusual unit shown at right. Known as the Power Divider, designed by Mack-International Motor Truck Corp., and employed on off-highway types of trucks, it transmits the drive smoothly to truck wheels yet produces increased torque to the wheel retaining traction when the other is slipping. A similar differential shown below, is used in addition for trucks with four-wheel drive bogies. In this unit the driveshaft is connected to the spline at left, the bevel gear driving the forward axle from the outer cam of the differential, and the shaft at the right driving the rearward axle from the inner cam.

During normal operation the differential maintains equal torque to both driven members while permitting differences in speed between them. When traction on one side is lost, however, idle spinning is prevented by increasing the torque to the wheel retaining traction. Driving member is a wide cage carrying twenty-four short radial plungers in two rows. These plungers can slide axially a short distance.





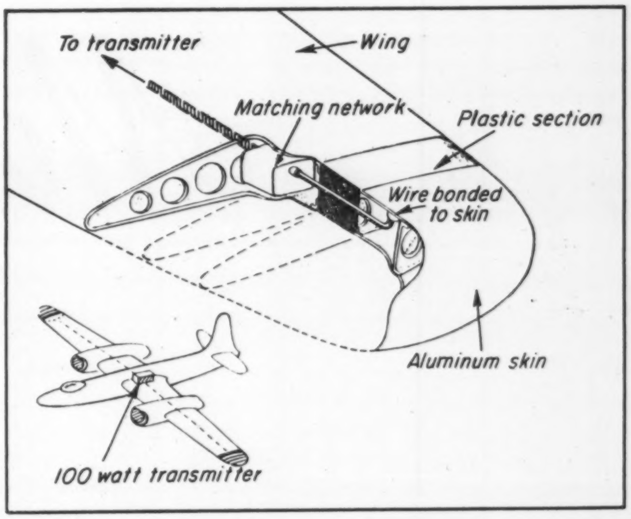
An inner cam is placed within the ring of plungers and an outer cam surrounds them, the plunger ends bearing on their respective cams. The two rows of plungers and the two rows of lobes on the inner cam are indexed alternately. The outer cam is indexed uniformly across its width.

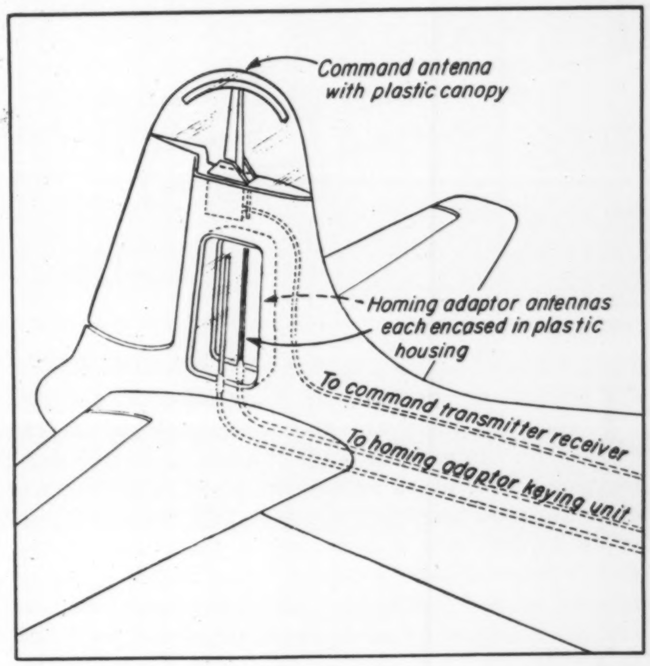
Relative motion between the driving ring and either cam reciprocates the plungers as they ride over the lobes. Because the cams are opposed, motion of one in one direction forces the other to turn in the opposite relative direction, providing for normal operation around corners and uneven terrain. Should one wheel tend to slip, any resistance whatever is multiplied three times by the cam angles, increasing the torque on the other wheel. In emergency use, light application of the foot brake increases the drag on the slipping wheel resulting in a net gain of 2 to 1 on the other wheel.

Flush mounted, zero-drag antennas, right, for speedy new USAF aircraft eliminate entirely the drag of the previously exposed types. For instance, a single streamlined one-foot stub antenna protruding from the surfaces would expend 200 horsepower at 600 miles an hour. Other advantages include the elimination of icing dangers, added protection from precipitation static, the sealing out of moisture, and freedom from breakage at high speeds.

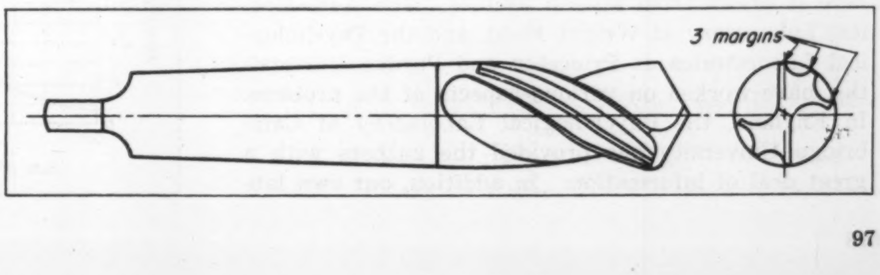
One of the latest developments is the use of all or part of the fuselage itself as an antenna. This technique has been necessitated by the utilization of low radio frequencies which require antennas sometimes as large as the aircraft they serve. By isolating a portion of the plane, such as a wing tip, and then feeding voltage across a plastic covered isolating section, the entire wing is thereby excited. Using the same principle in an isolated tail cap, the fuselage can be energized to act as an antenna. The wing can also be energized by inserting an exciter coil close to it in the fuselage and electrically inducting energy over into the wing structure.

Importance of flush mounting is illustrated by a C-54 cargo plane fitted with 15 dragless antennas of all types. Three are in the nose, two in the wings, four in the tail, two in the dorsal fin, and four in the fuselage. Figures compiled for only nine of these show that they would expend 634 horsepower at a hypothetical speed of 600 miles an hour. Flush mounted, they have no drag.



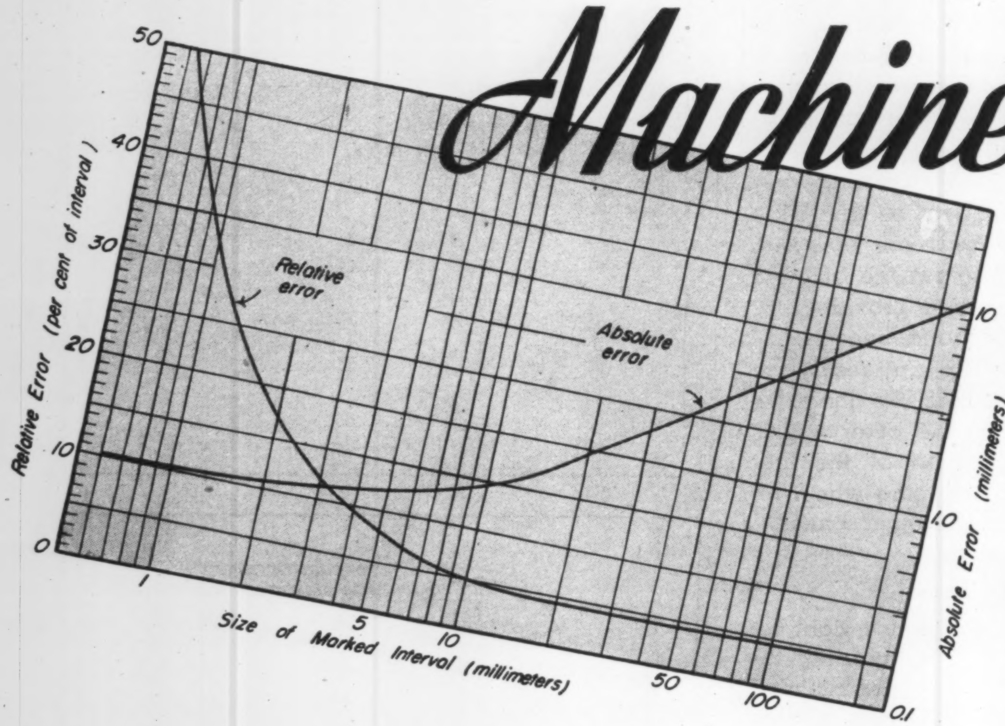

Command antenna with plastic canopy
Homing adaptor antennas each encased in plastic housing
To command transmitter receiver
To homing adaptor keying unit

Twist drills having three margins on each land as shown in the drawing below have proved superior to conventional single-margin drills for severe interrupted drilling jobs. When drilling 7/8 and 31/32-inch holes in the ears on SAE-1045 steel yoke forgings, the Saginaw Steering Gear division of General Motors experienced excessive breakdown of the margins on standard drills. The grinding room found it necessary, in most cases, to cut off a considerable length of drill to bring it back to condition for use. The new drill, designed with three margins gives better bearing, resulting in increased life, and has almost entirely eliminated the cutting off formerly necessary. Savings in drill and grinding costs have been over 50 per cent.



Machine dials

How to design them t



By W. R. Garner
and
J. W. Gebhard

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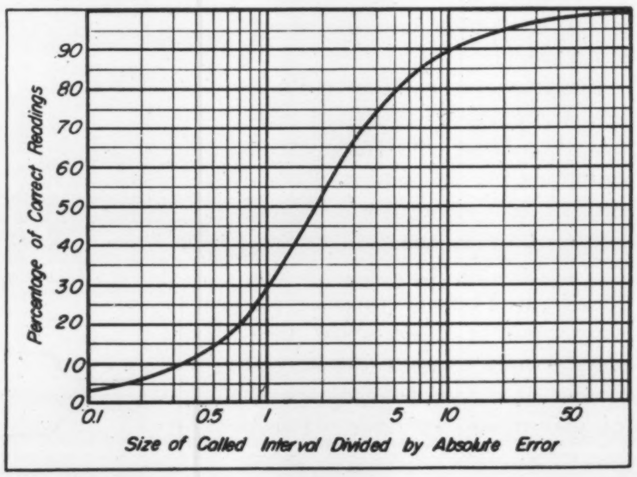
THERE are probably as many different dial designs as there are dial designers—and a few more. One quick walk through a test laboratory, or a tour of an automobile plant, will convince even the most skeptical observer that there are too many designs, and that not all of these designs are good. Sometimes it is not too important if a dial is misread or not read at all. At other times, however, critical mistakes are made, mistakes which may lead to serious injury or death. Many aircraft accidents, for example, have been attributed to a misread dial.

In recent years the importance of the dial in modern life has led to a considerable amount of research to determine the factors which make for good and bad dials and scales. Such questions as the following have been asked, and to a large extent answered: How precisely can a dial be read? How quickly can a dial be read? What is the best arrangement of dial markings, and how does the arrangement affect both speed and accuracy of dial reading? Again, how do the numbers which are marked on the dial, and the numbers used in reading the dial, affect speed and accuracy? What is the best kind of pointer? How should dials be grouped?

Many different laboratories have been working on these problems, and the material which is presented here is drawn from several sources. The Aero-Medical Laboratory at Wright Field, and the Psychological Laboratories at Princeton and Purdue Universities have worked on various aspects of the problem. In England, the Phychological Laboratory at Cambridge University has provided the authors with a great deal of information. In addition, our own laboratory has done a great deal of research on dial and scale designs. Most of this work has been supported in one manner or another, both in the United States and in Great Britain, by the Armed Services,

Fig. 1—Top—Readability of dials and scales is significantly influenced by the size of the marked interval. These curves show relative and absolute errors as a function of the size of the marked interval. Relative error is the error expressed as a percentage of the marked interval; absolute error is the actual error expressed in millimeters

Fig. 2—Below—This curve can be used to determine expected percentage of correct readings. It shows the percentage of correct readings as a function of the size of the called interval divided by absolute error



and scales

to insure quick, accurate reading

because these problems are of extreme value in the design of military equipment.

Before going into the cold facts of dial and scale designs, it should be helpful to describe first the various ways in which dials and scales are used. The best design for a dial depends a great deal on exactly how the dial is to be used. Unfortunately, the best dials for some uses are not the best for others.

It is generally agreed that all the uses of dials can be classed roughly into three groups: Check readings, directional readings, and quantitative readings.

Check Readings: The simplest form of reading is check reading wherein all the observer has to know is whether or not an indicator is at a correct point. He does not care at the moment what the actual reading is, but just whether the reading is what it ought to be. When a driver looks at the temperature gage on his car, he is not so much interested in the actual temperature as in whether it is the right temperature. Only when the temperature is wrong does he care what the actual reading is. For this type of reading, incidentally, a simple indicator such as a light which is on as long as the temperature is correct, is frequently better than any dial at all. Check readings can be made fastest when the indicator is as simple as possible.

Directional Readings: The next kind of dial reading has been called directional or qualitative. Here again the observer is not interested in an exact amount, but only in the direction of error—if there is an error. In the case of the temperautre gage, for instance, he would be interested only in seeing whether the temperature is too high or too low. Here again, the simplest form of indicator will give the best speed and precision of reading.

Quantitative Readings: Here the desire is to know precisely what the indicated value is and to get this precision as fast as possible. Most research work applies to quantitative readings, although the same general principles apply to all forms of dial readings. In anticipation, however, it can be said that a dial or indicator should never be more complex than absolutely necessary for the kind of reading required. Readings will be faster and more accurate the less complicated the design. On the other hand, it is fre-

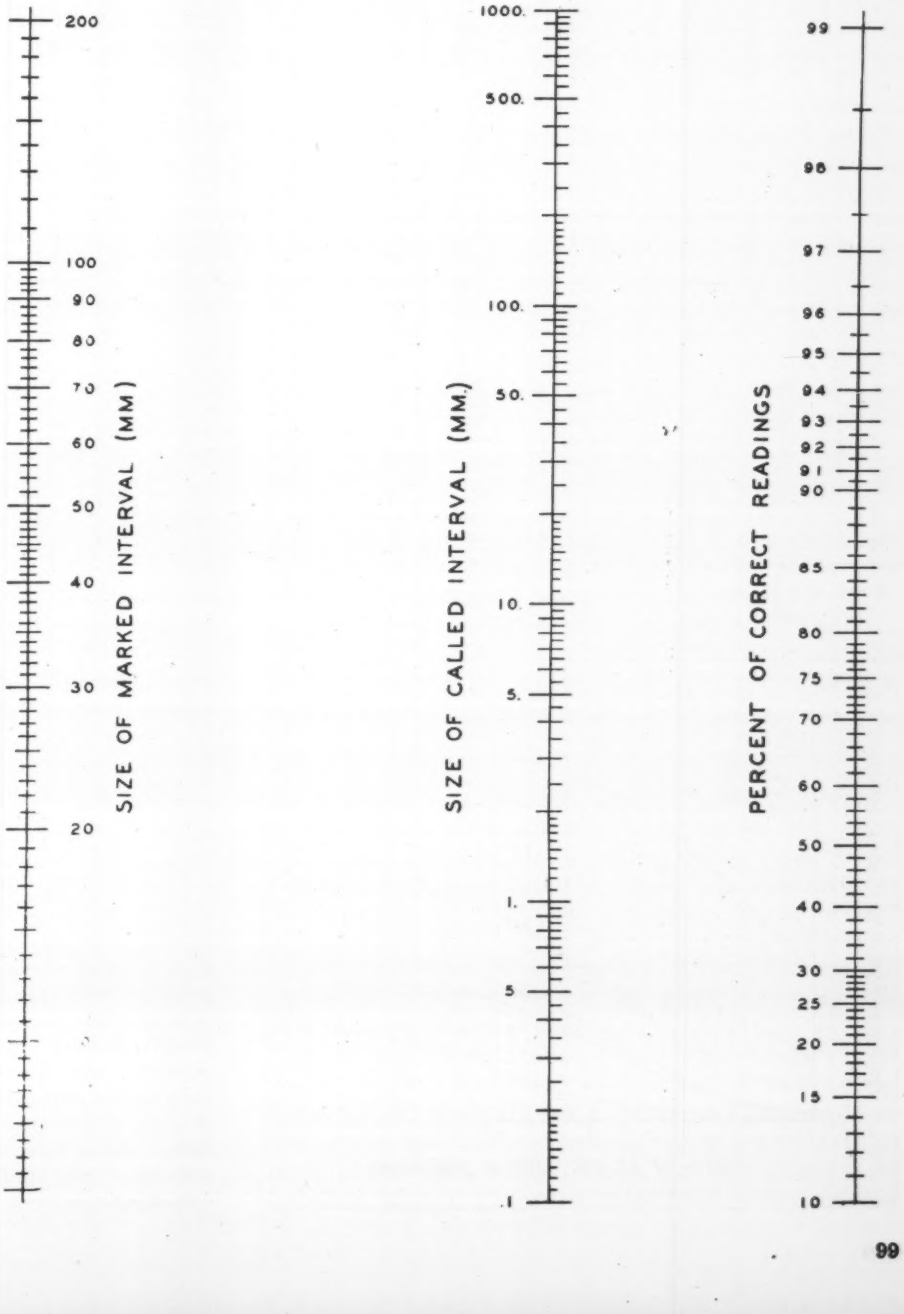


Fig. 3—Right—Nomograph permits reading percentage of correct readings to an interval when the sizes of the marked and the called intervals are known

quently necessary to design dials for all three kinds of readings. Many times, the need is for a check reading primarily, but also a directional or quantitative reading if the check reading is wrong.

Psychological Steps in Quantitative Reading: Making quantitative readings of a dial or scale is not a single phychological process. The first step is the gross perception of the general direction or area in which the pointer falls. This perception depends primarily on factors in the pointer design, and the overall size of the display—the larger the display the faster will the perception be. Next the dial reader has to determine the value of the nearest marked interval. This marked interval itself may be a submarking, in which case two successive judgments are required. And last, the reader must make a visual estimation of the fractional position of the pointer between two adjacent marks. He must, in other words, make a visual interpolation, and the accuracy of this interpolation is one of the critical problems of dial design.

Spacing of Dial Markers

Average Interpolation Errors: Studies on the accuracy of visual interpolation have been conducted at the John Hopkins laboratory,[1] at Wright Field,[2] and at Princeton.[3] Some of these studies dealt with circular scales, some with linear scales, and others with concentric scales. It seems to make little difference whether the scale is on a straight line, or whether it is a circular dial, so the discussion can be for the general case.

As has been indicated, size of the marked interval has a significant effect upon readability. It should also be noted that the values which follow represent errors for normal reading distances of about 20 to 30 inches.

Fig. 4—Correction factors applied to the size of the called interval for various fractional interpolations as a function of the size of the marked interval. These correction factors are used in conjunction with the nomograph of Fig. 3

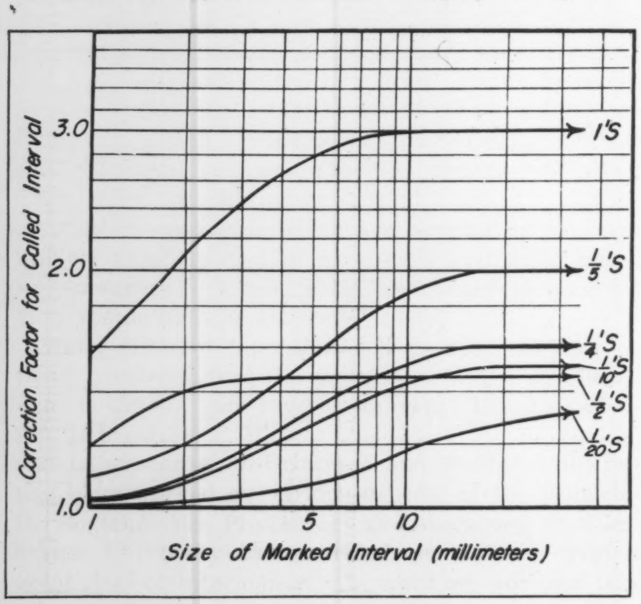


Fig. 1 shows both relative and absolute errors of visual interpolation as a function of the size of the marked interval. Relative error is very poor for small intervals, but becomes progressively better up to about 15 millimeters, where the relative error is about 4.4 per cent. This figure, then, represents the best relative accuracy which can be obtained under any conditions. It means that any given estimated interpolation will be in error (on the average) by 4.4 per cent of the interval. If many such readings are averaged *algebraically,* the mean value will approximate the true value very closely, since the errors are randomly distributed above and below the true value.

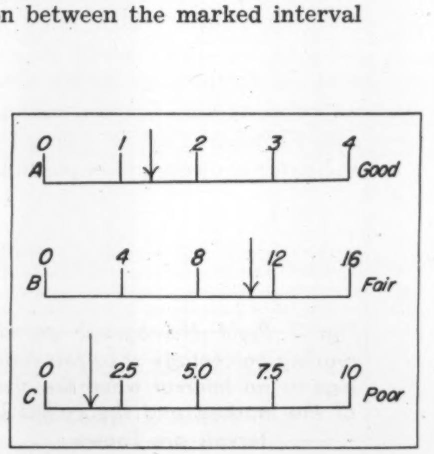
Absolute errors, on the other hand, increase linearly above 15 millimeters, but become progressively smaller below that value. They approach a limiting value of approximately 0.3 millimeters. It is possible that the lowest absolute error would be slightly less if observers squinted their eyes and moved a little closer, but they couldn't read dials very long under these conditions without undue fatigue. Once again, to interpret these figures, any interpolation reading made within the limits of 10-millimeter markings would be in error (on the average) by half a millimeter, or 5 per cent of the interval. To most people, these values are surprisingly large.

Reading to the Nearest Unit: Data such as those shown in *Fig.* 1 are of general interest, but they do not provide the direct answer to many technical problems. The curves refer to errors when the observer reads the scale as precisely as he can. More often, however, he reads to the nearest unit, whether that unit be one-fifth or one-twentieth of the interval. For example, a voltmeter is usually read only to the nearest volt (if the scale is large enough). In that situation it is important to know the percentage of times the reading would be correct to the nearest volt, not in the average error which is made.

From the average-error curves of *Fig.* 1, it is possible to compute the theoretical probabilities that any given reading will be correct to a given interpolation unit if size of the interpolation unit and size of the marked interval are known. These probabilities have been computed on the assumptions that the normal or Gaussian curve of errors applies and that there is an equal probability that the true reading will be at any infinitely small point on the entire scale. Later it will be shown that this first assumption must be modified for certain special cases.

There is a distinction between the marked interval

Fig. 5—Right—Interpolation accuracy depends on the interval numbers used on the scale. Accuracy will be best with A scale and poorest with C scale. B scale will give an intermediate accuracy



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[1] References are listed at end of article.

and the called interval. Size of the marked interval refers to the actual distance between markers on the scale. Size of the called interval refers to the actual size of the unit to which a reading is made. For example, assume that a scale is marked off every 5 millimeters, and the scale is labeled 5 volts for every mark. The size of the marked interval is then five millimeters. Now if a scale reader attempts to read to the nearest volt, the size of the called interval is one millimeter, or one-fifth of the marked interval. On the other hand, if the reader attempted readings to the nearest five volts, then the size of both marked and called interval would be five millimeters.

These probabilities, with different sizes of called interval are shown in *Fig.* 2. The size of the called interval is expressed as the number of absolute error units. This transformation is necessary in order to reduce all possibilities to one graph, and essentially makes the curve independent of the size of the marked interval. As an illustration, from *Fig.* 1 the absolute error for interpolating with a marked interval of 10 millimeters is 0.5 millimeters. Thus, if readings are made with the 10-millimeter marked interval to the nearest 2 millimeters, the size of the called interval is 4 times the size of the average absolute error, which gives a probability of correct readings of 74 per cent. If readings are attempted to the nearest 1 millimeter, the size of the called interval is twice that of the average error, and the percentage of correct readings is 53.

Likewise, for a marked interval of 5 millimeters, the absolute error is 0.4 millimeters. Now if readings are made to the nearest one millimeter, the called interval is 2.5 times as large as the average error, and the percentage of correct readings is 60. From this it can be seen that if readings are required to the nearest one millimeter of scale, more readings will be correct if the scale is marked off every five millimeters than if it is marked off every 10 millimeters. The relations shown in *Figs.* 1 and 2 are such that greater accuracy in reading to any specified called interval is always achieved the smaller the size of the marked interval, although the increased precision is not proportional to the increased total number of marks for marked intervals smaller than 15 millimeters.

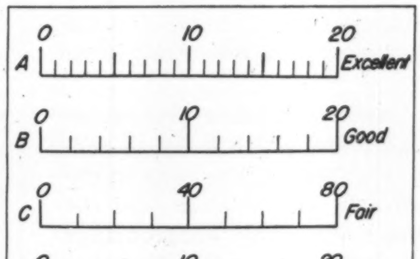

Fig. 6—Left — Good readability depends on how scales are divided. Here are examples of good and poor scale marker groupings

Nomographic Representation: To facilitate the determination of percentages, the nomograph shown in *Fig.* 3 has been prepared. This nomograph essentially combines the information shown in *Figs.* 1 and 2. On this nomograph, if a straight edge is lined up for the correct values of the sizes of the marked interval (on the left-hand scale) and of the called interval (on the center scale), the per cent of correct readings can be read from the right-hand scale.

Corrections for Special Cases: The nomograph is the best possible representation for the general case of scale reading. There are some special cases, however, in which correction factors have to be used to determine the best estimates of correct percentage readings. These special cases are due to the fact that some forms of fractionation are easier for human observers to use than are others. And, as will be seen, some numerical systems are easier to work with than others. It is easier and more accurate for observers to estimate in fifths of intervals than in fourths of intervals. Likewise, estimations to the nearest marked interval are much more accurate than any other type of interpolation, because it is much easier to determine the bisection point of an interval than any other fractional subdivision.

Correction Factor Enhances Nomograph Utility

Fortunately, the nomograph can be used even with these special cases by the simple use of a correction factor. This correction factor effectively reduces the size of the absolute error of estimation, which in turn can be treated as an increase in the size of the called interval. The size of the necessary correction factor varies with the size of the marked interval, as shown in *Fig.* 4. To illustrate how these correction factors are used with the nomograph, it will be assumed that a marked interval of 10 millimeters is to be read to various subdivisions. If it is read to a called interval of 10 millimeters, *Fig.* 4 shows that the correction for calling to units is 3.0 for a *marked* interval of 10 millimeters. The procedure is to multiply the size of the *called* interval by 3.0 before using the nomograph, and then read the nomograph for a marked interval of 10 millimeters and a called interval of 30 millimeters. This gives a percentage correct of 98.4, compared to the 95.0 per cent without the correction. If the interval is read to the nearest 2 millimeters, the correction for 1/5's is used, which is 1.85 for a marked interval of 10 millimeters. Reading the nomograph for a marked interval of 10 millimeters, and a called interval of 3.7 millimeters, gives a percentage correct of 86, compared to the 75 per cent without the correction. A similar correction process is used for all other cases. Fractionations not shown in *Fig.* 4 will have a correction factor too small to be worth bothering with. Therefore, the general case applies and the nomograph should be read directly.

It should be pointed out that the nomograph is based on data extensive enough that it can be assumed that the future will produce little change in it. The correction factors for marked intervals greater than 15 millimeters are likewise well determined from existing data. The correction factors for smaller

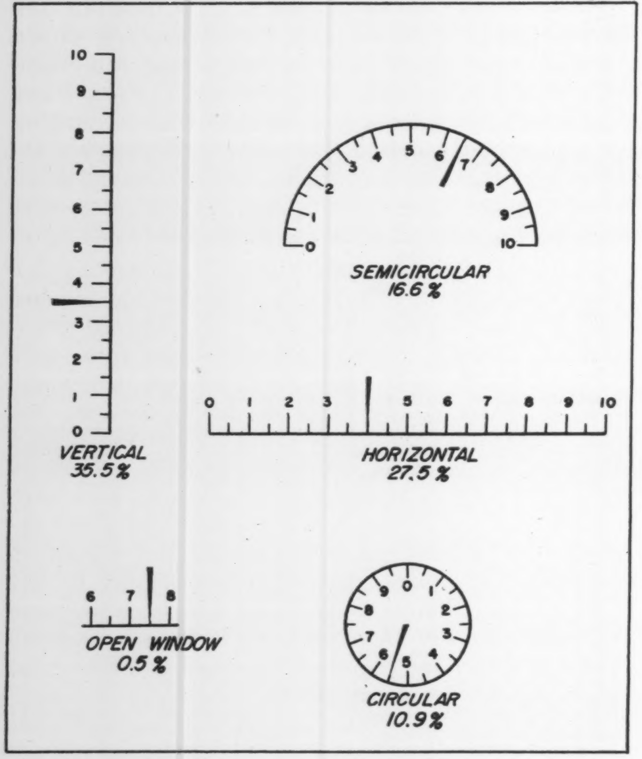

Fig. 7—Accuracy of scale reading depends on type of scale used. Error scores obtained in experiment are shown as the per cent under each scale

marked intervals, however, are based on a minimum of data, and a maximum of logic and practical considerations. The corrections for the shorter intervals, then, are the best possible at the moment, but they may be changed with future research.

These correction factors produce some interesting conclusions and generalizations. One thing which can be noticed is that a marked interval of a given size can be read to fifths as accurately as it can be read to fourths. Also, reading to the nearest half of a marked interval is not a great deal more accurate than the general case. The general conclusion is that systems of fractionation in fives and tens are better than those which go by successive bisection, as from units to halves to quarters, eighths, etc. It would seem that the metric system of scales not only would make calculations considerably easier, but that scales using the metric system could be read more accurately.

THE SCALE NUMBERS: A word of caution should be imposed at this point. The corrections shown in *Fig.* 4 assume an optional number system, and will not work with a poor number system. Research at this laboratory[4] has shown that interpolation accuracy is much better with some number systems than with others. In Fig. 5 are shown three scales which will not be read equally well when accuracy is measured in terms of absolute distance on the scale. Scales which increase by units are best—such as 1, 2, 3, 4, or 10, 20, 30, 40, etc. (A scale is called a unit scale if the numbers increase by integral units, or any number which is 10, 100, etc., times an integral unit.) The *C* scale in *Fig.* 5 is one of the worst possible scales, and the *B* scale is just fair. Other poor number systems are those which go by threes, sixes, and sevens. Worse still would be scales which go by eights. Scales which go by twos are almost as good as those which go by units.

The correction factors in *Fig.* 4 are for a scale which goes by units. These corrections will be lower, or disappear altogether if other number systems are used. For example, a scale of seven interpolated to one-tenth of the interval would be very awkward and no correction should be used. On the other hand, a scale by fours called to the nearest fourth would have a slightly higher correction than that shown. The critical factor is not so much the fractionation value itself as it is the number which is used for a particular fractionation. In general, the fractionation which will be best for a particular number series is that which will allow readings in units. A scale of three, for example, read to the nearest third is better than a scale of three read to the nearest fifth, and would have a larger correction factor.

Unit Systems Always Best

Unfortunately, there is no general rule which can be given which would cover all cases. It should be possible, however, to determine the rough correction if it is borne in mind that unit systems are best for all cases. Thus the maximum correction would be for a scale marked in units and called in a unit system—the metric scale. Corrections will in general be less if either the marked scale or the called scale deviates from the unit system. However, a few checks of percentage correct readings with the different correction factors will clearly show that the use of a good number system greatly increases the accuracy of scale readings.

METER MULTIPLIERS: Meter multipliers always change the scale to some extent, but sometimes the change in scale results in a very inaccurate scale from which to read. For example, a scale may be well constructed in that it has unit numbers for the marked intervals, and thus can be easily read to unit numbers. But if that scale is multiplied by 2.5 (a not uncommon multipler) the accuracy with which it can be used becomes exceedingly poor. In general, the best multipliers to use are tens, hundreds, etc., or twos, twenties, etc. Multipliers of five are not too bad, but almost any other multiplier will result in an inefficient scale.

MARKER GROUPINGS: Another related problem is the use of unnumbered markers, which serve as partial subdivisions of the total scale. The same problems arise here as in straight interpolation, and the conclusions are the same.[5] The best subgroupings to use are fives and tens, designed in such a way that a decimal or unit system of numbers can be used. On the other hand, if the numbered scale is a scale of four, then four subdivisions are better than five. Again, the basic generalization is that the scale should be read to a unit number, i.e., the smallest marked scale division should be a 1, 2, 3, etc., or 10, 20, 30, etc.

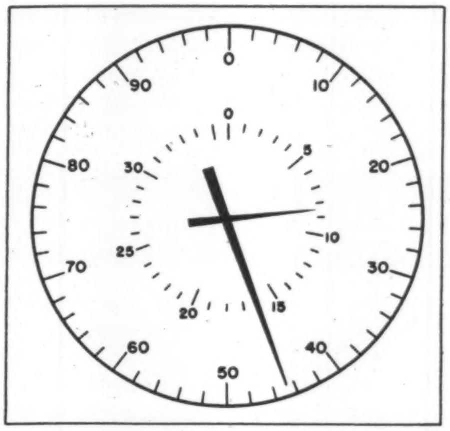

Fig. 8—Left—Reading of multirevolution dial usually is subject to many errors

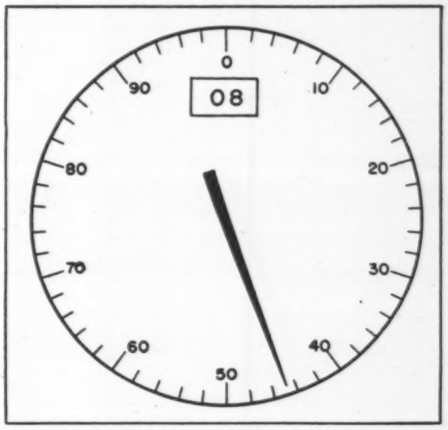

Fig. 9—Right — Combination dial and counter can be read with much greater accuracy than the equivalent multirevolution dial shown in Fig. 8

Some good and bad scale groupings are shown in *Fig.* 6. The top scale is the best possible. The numbered scale is in a unit decimal system, and the smallest marked division gives unit numbers. Interpolations between the smallest marked intervals will have the largest correction factors if it is read to units, fifths or tenths of the interval. On the other hand, the scale at the bottom, even though it has ten subdivisions, is an extremely poor scale because the numbers used at every stage of the reading are in awkward steps. Likewise, the *E* scale is poor even though its numbered markers are good because the numbers for the subdivisions are poor and will produce inaccurate interpolations.

Speed vs Accuracy: In general, the factors which produce maximum precision will also produce maximum speed. Particularly is this true with reference to the problem of numbers and subdivisions. On the other hand, there is one factor which increases accuracy but decreases speed: the total number of marked intervals on the scale. Because of the large correction factor for interpolating to the nearest marked interval, it is always more accurate to have one marked interval for every interval to which the scale is read than to use any other system of interpolation. But the more marks there are, the greater the time required to get a precise reading, and the greater the chance that a scale division or mark will be read wrong if the scale is read quickly.[5] Marked intervals less than about three to five millimeters produce relatively little increase in accuracy, but adding more marked intervals will greatly slow down the reading process. Thus except for real precision scales, where it can be assumed that considerable time is taken in the reading, scale markers of less than 3 millimeters separation probably should be avoided.

What Kind of Dial?

Another kind of problem which affects primarily the speed with which a dial can be read is the shape of the dial. For real precision reading, the shape of the dial is of little consequence. However, if readings are made quickly, accuracy becomes less with conditions which produce slow readings where the dial reader takes as long as he wants. There are, in other words, conditions which will produce slow readings. These same conditions will also produce inaccurate readings if the reading is forced to be fast, although no inaccuracy would result if the reader took all the time he wanted.

One factor which affects the dial readings this way is the shape of the dial.[6] In *Fig.* 7 are several kinds of dials which were studied experimentally, with the percentage of errors which were made on a forced fast reading. The open-window type of dial was considerably better than any of the other shapes of dials in terms of errors. The errors in this case were a misreading of the nearest marked interval. What seems to happen is that less confusion results if only two or three numbers are visible. The nearest scale number can be determined much faster by actually reading one of a few numbers than by trying to pick out one number from many. In this experiment, incidentally, the spacing between marks was the same for all dials, so that the only factor that could affect accuracy was the shape of the dial itself.

When To Use Counters

Counters Instead of Dials: A problem related to the shape of dials is whether a dial has to be used at all. Experiments in this Laboratory[7] have shown that counters can be read more accurately and quickly than a circular scale. The psychological stages involved in reading a dial, which we mentioned earlier, are short-cut when a counter is used. There is no gross localization, and there is no interpolation required. It probably is safe to say that whenever quantitative information is required, it can be obtained faster from a counter than from a dial. There are practical limitations to the use of counters, however, which limit the cases in which they can be used. If scale readings change rapidly, then the counter becomes practically useless because the fine unit moves so fast it cannot be read. Likewise, the counter is of little value when the task is to set some control to a particular value, since the operator does not know what the actual value on the counter is unless he stops his adjustment.

Substitute for Multirevolution Dials: One excellent application of the counter, however, is as a partial substitute for the multirevolution dial. Experiments at Wright Field[8] have shown that the multirevolution dial, *Fig.* 8, is a very poor instrument to read. Many misreadings are made, and it takes a long time to get a correct reading. *Fig.* 8 shows why it is so awkward. If the inside and outside scales are not the same, knowing the gross position of the pointer is of little value. Likewise, when the outside pointer is near zero, the inside pointer will frequently be misread by a whole unit.

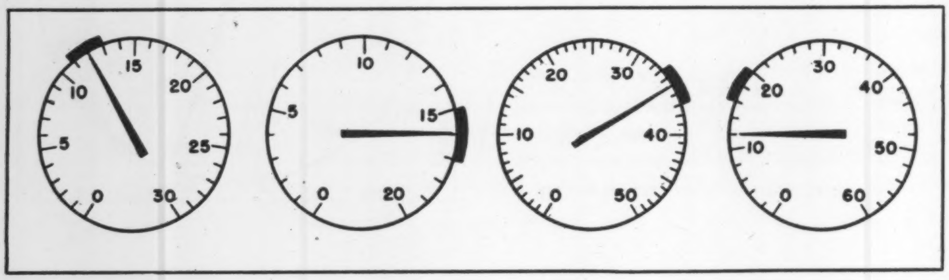

Fig. 10—Left—For check reading dials, the area of correct readings should be clearly marked

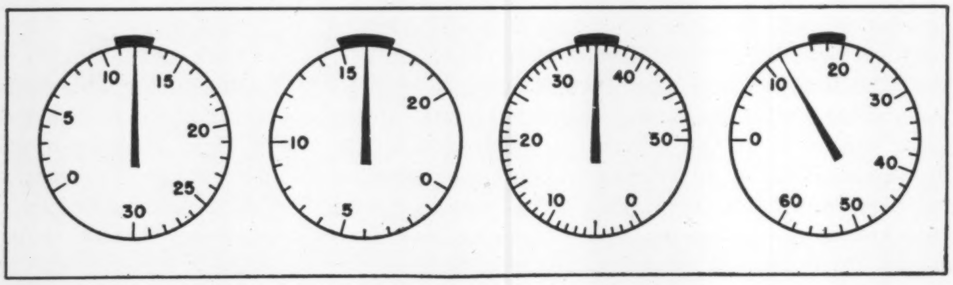

Fig. 11—Right—When groups of dials are used primarily for check reading, a misaligned dial can be spotted much more quickly if all correct-reading areas are in the same relative location. Compare this group of dials with those of Fig. 10, for example

In *Fig.* 9 the same reading is shown with a counter substituted for the inside scale, and the outside scale remaining the same. This combination dial and counter can be read much more accurately and faster than the multirevolution dial.

Two-Speed Mechanisms: This substitution of the counter for one of the multirevolution scales can also be considered as a means of providing a two-speed mechanism. It was mentioned that counters are poor whenever rapid movement occurs. There are in addition purely mechanical difficulties involved in trying to move a counter too rapidly. One compromise is to use the counter as the slow unit (with the coarse reading) and the dial as the fast unit (with the precise or vernier reading). Thus a dial which uses just one complete revolution could be changed to have a counter record every ten degrees of movement, with the dial expanded to read in-between values. Precision and speed of readings would be greatly increased by such a change.

Patterns of Dials: Relatively little has been said about check and directional readings. In general, the same principles apply to these types of readings, but are less important. However, the factors which affect speed should be given primary consideration, rather than the factors which affect accuracy. Few markings are needed for check and directional readings, and the use of few markings will greatly increase the speed of dial readings.

For check readings, the problem of groups of dials becomes important. If a single dial is to be used primarily as a check reading instrument, and only secondarily as a quantitative reading instrument, it should have some clear mark to indicate the correct reading. Marks such as those drawn on the dials of *Fig.* 10 are one means of improving the speed of check readings. However, if a whole group of dials is to be used for check reading, the reading will be made considerably faster if all correct readings are oriented in the same direction.[9] In *Fig.* 11 all the dials of *Fig.* 10 have been rotated to make the correct reading appear on the top for every dial. A comparison of these two figures will immediately show that the one misaligned meter can be spotted faster in *Fig.* 11 than in *Fig.* 10. Incidentally, rotating the dials in this way does not decrease the accuracy with which quantitative readings can be obtained from the same dial.

Miscellaneous Design Problems: There are a few additional design factors which are minor, but of sufficient importance to deserve some mention. The pointer, for example, should have a fine tip, with a long taper. If possible, the taper should start at the center of the dial (for circular type dials).[10]

On circular scales, there should be a break between the beginning and the end of the scale.[5] It is not important where the break occurs, which is another way of saying that it makes little difference whether the scale starts at the top, the bottom, or the side.

Readings on scales will be less precise when decimals are used for the scale numbers.[5] At times, of course, decimals cannot be avoided. When they are used, however, readings will be faster and more accurate if the zero in front of the decimal point is omitted. The additional zero may look more precise, but it actually makes readings less precise.

Likewise, nonlinear scales should be avoided wherever possible.[7] When a logarithmic scale is used, for example, it takes longer to determine the value of the nearest marked interval because the marked intervals are not equally spaced. In addition, interpolations will be less accurate with logarithmic scales. Once again, of course, there are times when it is absolutely necessary to use nonlinear scales in order to get all the information on a single scale, or on a graph. In such a case, other design factors must be fitted into this basic requirement.

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Redesigned for Eye-Appeal

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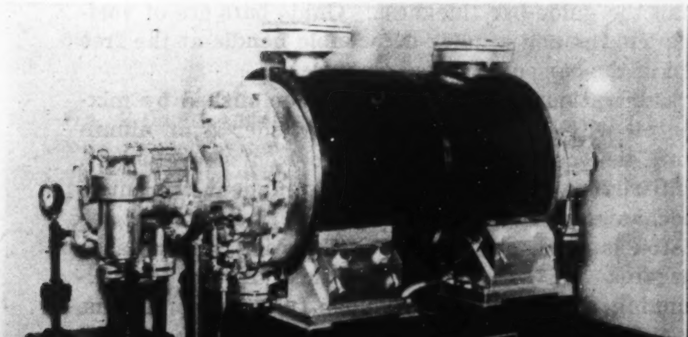
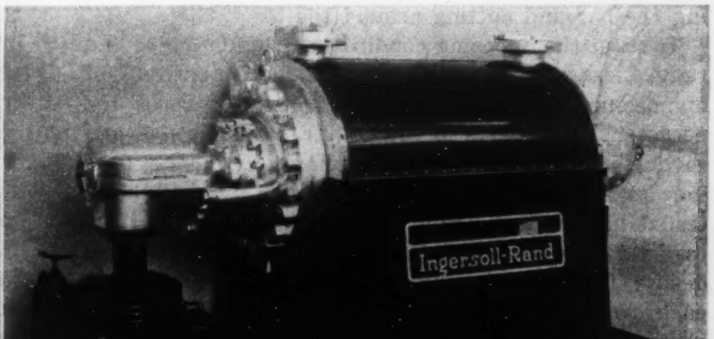
REDESIGNING for appearance will often result in a machine that is simplified both from a manufacturing and assembly standpoint and is also cheaper to produce. The centrifugal pumps made by the Ingersoll-Rand Co. have in the past been designed with little attention to the appearance of the finished product, being purely functional in nature. As will be apparent from the photograph at the left, while the arrangement is satisfactory mechanically, the assortment of thrust bearing, oil pump, relief valve, pressure gage, oil reservoir, oil cooler, oil cleaner, and piping does not present a good appearance.

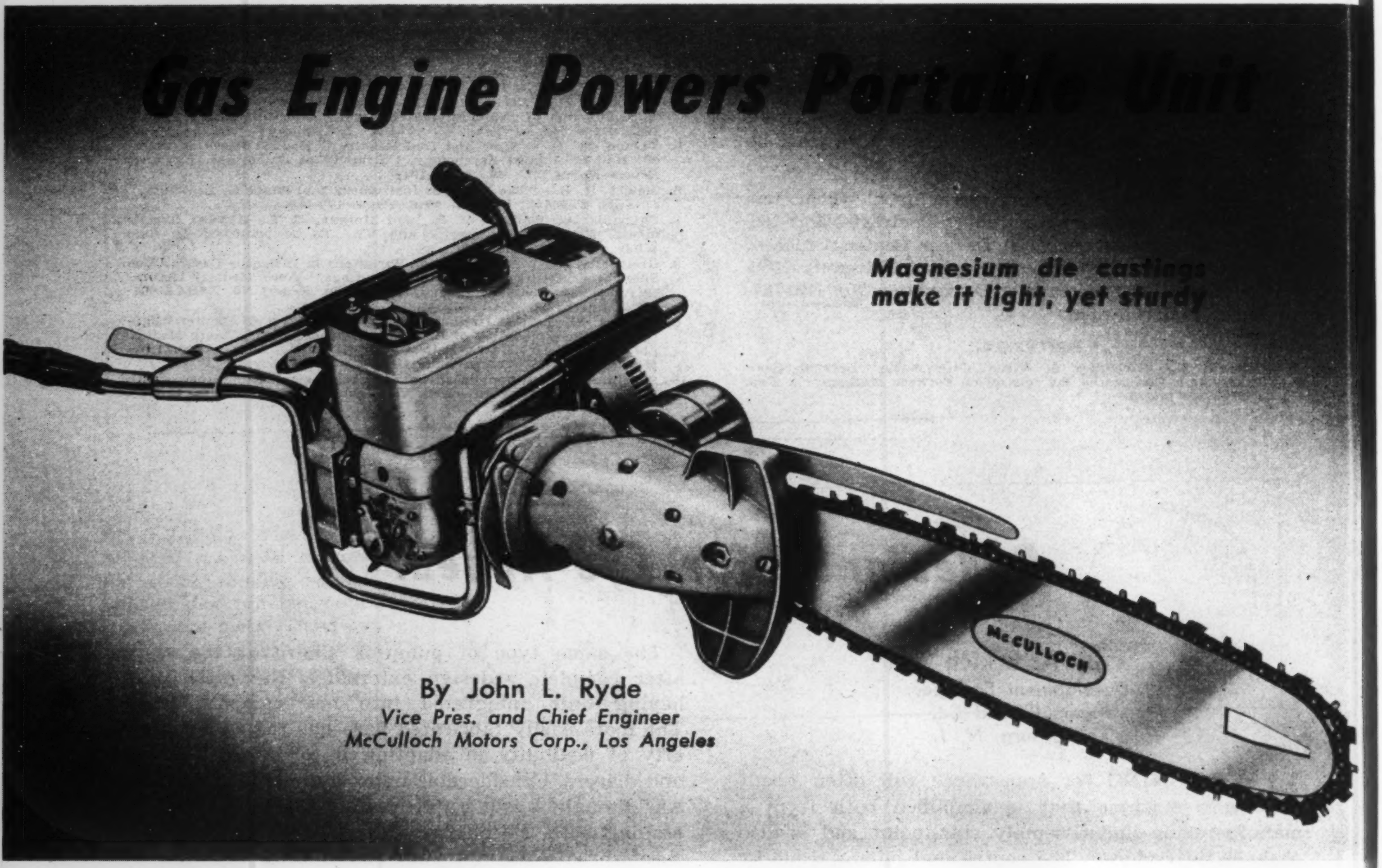
The same type of pump is shown at the right after complete redesign externally, the entire unit having been integrated into one compact mass. The more easily fabricated base has the added property of flexibility in adapting it to different pumps and drivers. Considerable improvement in appearance was brought about by concealing the piping and installing both the cleaner and relief valve inside the reservoir. Some oil lines have been replaced by passages in the oil pump body. Since the oil cooler is subject to customer's specification and may vary considerably in size, it was intentionally left exposed.

The main flange of the pump was not changed. It was felt that the uniform circle of large nuts gave the machine a rugged appearance which suggested its high-pressure service. These pumps are of the double casing type, designed as boiler feed units for power station service at up to 2900 psi pressures.





Gas Engine Powers Portable Unit



Magnesium die castings make it light, yet sturdy

By John L. Ryde
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PRIMARY requirements of the gasoline-engine powered chain saw shown in *Fig.* 1 are light weight and sturdiness. Light weight because it is a hand tool, and sturdiness because it must be capable of withstanding considerable abuse in extremely severe service conditions normal to its operation. It is used for cutting all types of timber five feet or more in diameter directly, and much larger timber by burying the bar and cutting around the tree.

To meet the opposing conditions of light weight and ruggedness, this machine is constructed entirely of magnesium die castings with the exception of the necessary steel parts in the engine, transmission, and sawing mechanism, and an aluminum cylinder. During its development, a large number of units were tested in the field under actual operating conditions to determine weak points of construction. The final design is something like the "one-hoss-shay" with each part just strong enough to take care of its share of the burden and abuse with as little excess weight as possible.

Fig. 1—Top—Prime requirements of this portable chain saw—light weight and sturdiness—are adequately met by generous use of magnesium die castings

A horizontal, single-cylinder, two-cycle type, the engine is equipped with its own fuel supply, starter and cooling system. It delivers its five brake horsepower at 4000 rpm to the saw-chain sprocket through a centrifugal clutch attached to the crankshaft and a right-angle bevel-gear drive. The chain rides around a milled track on the guide bar and is equipped with cutter bits which cut a kerf somewhat wider than the guide-bar thickness. Guide bars are of various lengths and a quick-detachable handle at the free end of the bar permits two-man use.

Lubrication of the engine is accomplished by mixing oil with the gasoline. The cylinder is an aluminum die casting having a nickel-iron sleeve insert. Antifriction bearings are used throughout the entire mechanism even to the wristpin bearings. A flat-top piston is used, and this in combination with a large fin area on the cylinder and head insures a cool-running motor under continuous full-load conditions.

A flywheel type magneto is employed with the coil and lamination assembly external to the rim of the flywheel. The high peripheral speed of the magnet assembly on the flywheel rim insures a hot spark even at low starting speeds. It is interesting to note that the mass of the magnets proper together with their counterbalance on the opposite side of the flywheel provide sufficiently high inertia as to permit the rest of the flywheel being diecast magnesium.

Inasmuch as the saw is operated intermittently, the unit is fitted with a recoil starter to facilitate the frequent starting of the engine. These starters, however, are often prolific sources of trouble in that the "kick back" or reverse rocking of the engine pulls the cable in, either breaking it or damaging the starter mechanism. To overcome this difficulty a somewhat different design, shown in *Fig.* 3, was used on the starter, so that it disengages automatically if turned in the reverse direction. The starting torque is transmitted by a coil spring acting as an overrunning clutch on the starter shaft proper. One end of the spring is bound lightly in the starter housing, so that a reverse rotation of the starter shaft causes the spring to unwind and release.

Unconventional Carburetor is Gravity Fed

Fuel is fed into the carburetor by gravity from a tank on top of the engine. The carburetor is unconventional in that a diaphragm chamber replaces the usual float chamber. This diaphragm acts as a pressure regulator and establishes a given level at the carburetor venturi, but it is independent of the direction of gravity so that it can be operated in any position. This permits the engine to run under a wide range of angular positions; in fact it will operate in any position as long as fuel is fed to it. Often the machines are stood on end in making difficult bucking cuts, and this carburetor assures continuous engine operation under these conditions.

As shown in *Fig.* 4, the carburetor proper is "split down the middle". Parting the carburetor through the center of the venturi permitted casting of the various fuel and air passages directly and eliminated many drilling operations. In addition to this, the air cleaner chamber is incorporated in the carburetor body.

Because the unit usually operates in a cloud of sawdust and dirt, the air cleaner is an important accessory. A cylindrical air cleaner cartridge of the viscous impingement type is used with the air flowing from the inside out. A brush is built into the assembly and by actuating the brush up and down, the cleaner element can be scavenged while the engine is in operation. The element is easily removed through the top of the carburetor for periodic washing to remove fine dust.

To facilitate engine operation, all engine controls are grouped in a panel on the top of the gas tank. These include the primer, combined carburetor adjustment and fuel shut-off valve, ignition switch, and the air cleaner brush. The spring-loaded throttle is operated from either a thumb lever on the right handlebar or by twisting the crossbar. This location of the throttle permits easy manipulation of the unit when used by either one or two men.

The right-angle transmission through which the engine drives the saw has a five-to-one reduction ratio. Located between the engine and the transmission unit, the centrifugal clutch engages at approximately one-half rated engine speed. The entire gearcase and blade is mounted on the clutch housing so that it can be rotated 360 degrees around the axis of the engine unit and locked in any position by a toggle-operated clamp ring. This arrangement permits the operator to adjust the angle of the blade for the various operations of felling, notching, ripping or straight crosscut.

Quickly detachable from the transmission, the guide bars are of various lengths to meet all types of cutting conditions and can be interchanged conveniently. The bar is mounted on two studs on the transmission housing which engage slots in the end of the bar, so that the chain tension can be adjusted by moving the guide bar out. To insure correct tension, two spring-loaded lugs engage two holes in the bar, forcing it out and applying tension to the chain. The bar is then

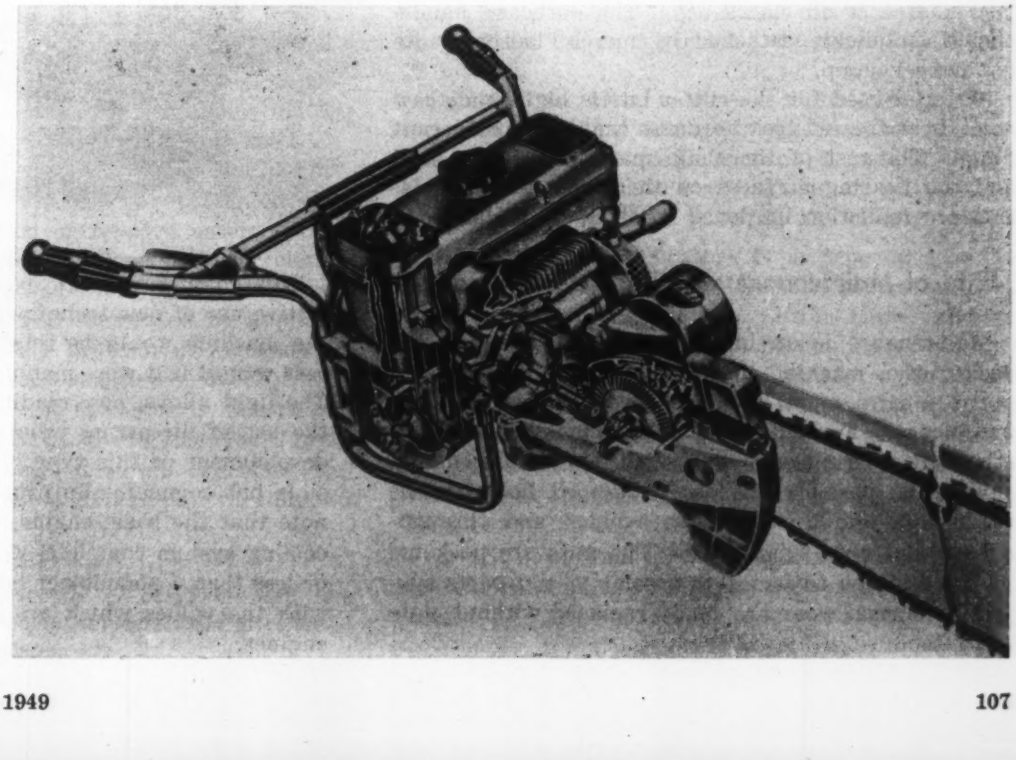


Fig. 2—Right—Cutaway view shows how single-cylinder engine drives through centrifugal clutch and right-angle bevel-gear

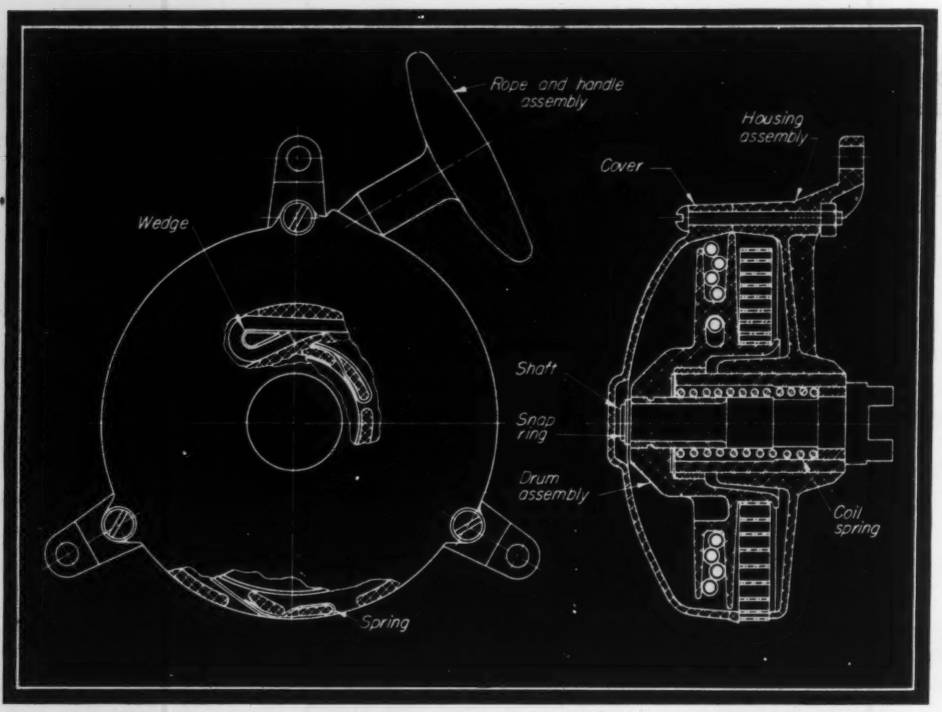


Fig. 3—Left—Built-in pull-rope starter. Starting torque is transmitted by coil spring acting as overrunning clutch on starter shaft. Reverse rotation of starter shaft causes spring to unwind and release

locked in this position by a clamp plate tightened by a hand knob.

Fabricated from high-grade saw steel the guide proper is heat treated to spring temper. The milled track around the outside edge constitutes the guide for the chain and as such it is subjected to severe wearing conditions. To reduce wear and friction along this edge, it is locally hardened and the entire bar hard-chrome plated.

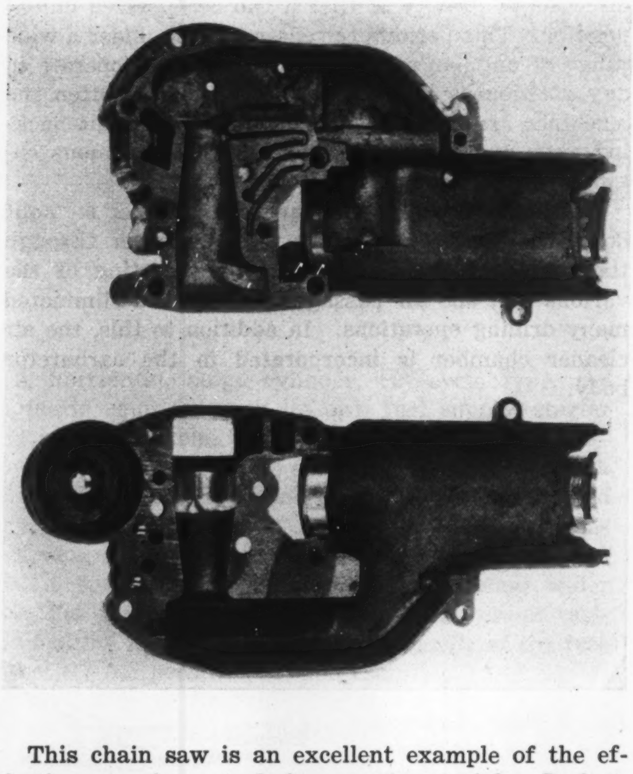
This combination eliminates the need for an idler at the free end of the bar and the chain track is continued around the end on a radius. This arrangement makes the operation of the saw convenient as it can cut "blind" by burying the bar; it can be used for boring to start a cut by mortising the bar into the tree, and it can be quickly removed from a cut by pulling out in case of an emergency. The outboard handle shown is quickly detached by merely loosening its handwheel clamp.

Material used for the cutter bits is high-grade saw steel, heat treated to a hardness that will just permit filing. The rest of the chain material is alloy steel and the bearing surfaces on the rivets for articulation are induction hardened to above 60 Rockwell C.

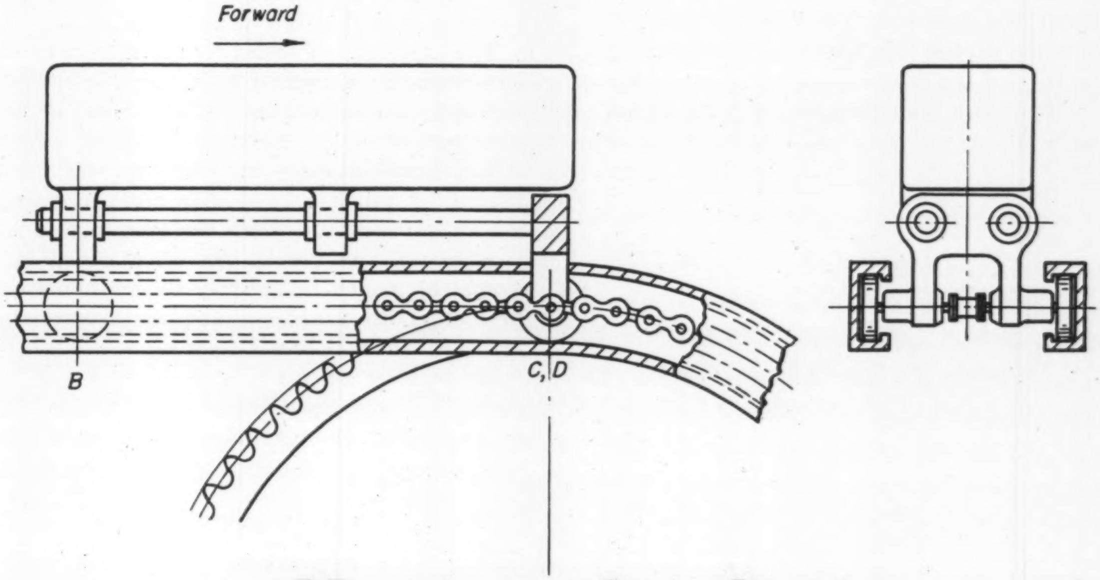
Ease of Maintenance was Prime Consideration

Maintenance is an important consideration in the design of a machine like a chain saw, because frequent repairs must be made for accidental damage and abuse. For this reason the machine was constructed to permit easy disassembly and maintenance. Insofar as possible the use of tapped holes in the magnesium die castings was avoided and through-screws and nuts substituted. The nuts are pocketed in the castings to facilitate assembly, and parts subject to normal wear are easily replaced without elaborate tools.

Fig. 4—Below—Casting of carburetor fuel and air passages eliminated many drilling operations. Photograph shows the two magnesium die-cast carburetor halves



This chain saw is an excellent example of the effective use of new techniques and materials. In fact, the machine would be totally impractical due to excess weight if it were manufactured by older methods. The light alloys, now readily available, together with the use of diecasting processes combine to make the development of this type of equipment not only possible but commercially practical. It is of interest to note that the basic engine for the saw, including the cooling system complete, weighs less than 14 pounds, or less than 3 pounds per horsepower. This compares with the values which are attained in small aircraft engines.



Motion Analysis

. . . of a high-speed conveyor illustrates problem of machine elements with combined rotating and sliding motion

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ERRORS in motion analysis of high-speed mechanisms inevitably occur with the application of solutions requiring graphical differentiation. Reduction of such errors with a more specific definition of instantaneous conditions has prompted the development of the method of relative accelerations using Corioli's "compound supplementary acceleration." Adaptability of the solution, partly graphical and partly analytical, is well illustrated by application to a somewhat unusual problem in kinematics, that of a high-speed special purpose conveyor.

General arrangement of the conveyor is illustrated in *Fig.* 1. The car runs on rollers in guide tracks and is driven by a roller chain. It is pin connected to the chain at both the front and rear pair of rollers.

Fig. 1—Top—General arrangement of conveyor used to illustrate method of determining velocities and accelerations graphically

In rounding a turn, the chain passes around a sprocket and the guide tracks describe a circular arc of the same radius as the sprocket. Telescoping wheelbase arrangement is necessary to compensate for the difference between chordal length and the distance along the chain between rollers. Fully extended, the wheelbase of the car is 16 inches; radius of the turn is 12 inches.

Combination of a relatively high velocity of 20 fps with the sharp turns introduces substantial acceleration forces as major factors of design. Simply analyzed, the problem becomes one of a link in a mechanism having both rotating and sliding motion.

DEFINITION OF PROBLEM: It is necessary to find the linear and angular accelerations at the center of gravity of the conveyor car. From these accelerations may be found forces to be applied in strength calculations and estimations of power requirements.

Distinct phases of motion may be recognized from a preliminary study of the problem. Consider for analysis a 180-degree turn. It will later be shown that turns of other angles are easily soluble in terms of the 180-degree solution.

First it is obvious that for uniform speed along the straight runs of the conveyor there are no accelerations.

Secondly, for a portion of the turn both front and rear pairs of rollers are contained in the curve. For this portion of the curve the motion is one of pure rotation about the center of the circular arc. The only acceleration during this phase is the centrifugal acceleration toward the center.

However, there is a transition on entering or leaving the turn when one pair of rollers is on the straightaway. The accelerations during entering and leaving phases are highly complex and may be substantially higher than the purely centrifugal acceleration. Also, they are constantly changing as the car assumes different positions around the turn so that it becomes necessary to compute them for a number of different positions and plot them to be sure of finding the maximums.

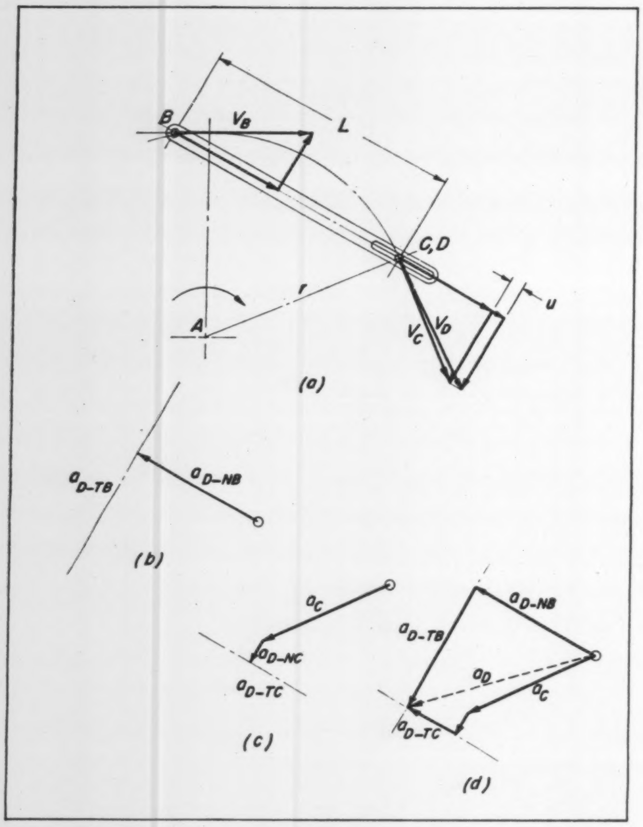

Fig. 2—Kinematic equivalent of mechanism, with velocity and acceleration diagrams

Development of Method: The telescoping conveyor car in kinematically equivalent to the sliding link shown in *Fig.* 2, the motion of which is easier to visualize. Points indicated in the figure are:

- *A* is the center of the circular arc (also of sprocket)
- *B* is the center of the trailing pair of rollers and is fixed relative to both the link and the chain
- *C* is the center of the leading pair of rollers. It is fixed with respect to the link
- *D* is a point on the link which instantaneously coincides with *C* but is moving in a different direction with different velocity and acceleration

If the accelerations of two points on the link are known, the acceleration of any other point may be found. Point *B,* for the position shown, is on the straightaway and moving with constant velocity. Its acceleration is therefore known to be zero. The problem is to find the acceleration of *D.*

The method of relative accelerations is used.[1] However, when applied to a link having both rotating and sliding motion, this method is incomplete. Another vector is introduced known as the "compound supplementary acceleration" (Corioli's law), neglect of which may lead to serious error.[2, 3] Corioli's component has been included in this solution.

Although the result can be attained entirely by graphical means or entirely by mathematics, in this problem both graphical and mathematical methods are used where it seems most convenient.

As will be shown, there are two unknown components of the acceleration *D.* The approach, then, is essentially the graphical solution of two simultaneous equations for the acceleration of *D:*

$$a_D \text{ with respect to } B + \!\!\rightarrow a_B$$

$$a_D \text{ with respect to } C + \!\!\rightarrow a_C$$

First step in the solution is to determine the velocities at the point involved. Referring to *Fig.* 2*a,* the velocities of *B* and *C* are equal in magnitude to the chain speed, 20fps. Velocity V_B is directed parallel to the chain at *B,* and V_C is tangent to the arc at *C.* These velocities are then resolved parallel and normal to the axis of the link as shown in the diagram. It is evident that the normal component of V_D must be equal to the normal component of V_C since there is no relative motion in that direction. The parallel component of V_D is equal to the parallel component of V_B because all points fixed to the link along its axis must have the same velocity parallel to the axis. Difference between the parallel components of V_D and V_C is the velocity with which *C* is moving with respect to the slot and is called *u.* For the position illustrated, *u* is directed toward *B.*

Another quantity of importance is the angular velocity, ω. This is equal to the vector difference of normal components of V_B and V_D divided by the distance between the points, *L:*

$$\omega = \frac{V_B \rightarrow V_D}{L} \quad \dots\dots\dots\dots\dots\dots\dots\dots (1)$$

It is now possible to compute most of the required acceleration vectors. The total accelerations of *A* and *B* are known to be zero. The total acceleration of *C* is pure centrifugal acceleration directed toward *A* and is equal to

$$a_C = \frac{V_C^2}{r} \quad \dots\dots\dots\dots\dots\dots\dots\dots (2)$$

where *r* is the radius of the turn. One component of the acceleration of *D* is readily found. Since the link has an angular velocity, ω, point *D* has a centrifugal component directed toward *B,* equal to

$$a_{D-NB} = \omega^2 L \quad \dots\dots\dots\dots\dots\dots\dots\dots (3)$$

Another component of the acceleration of *D* can

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[1] References are tabulated at end of article.

(*Continued on Page* 180)

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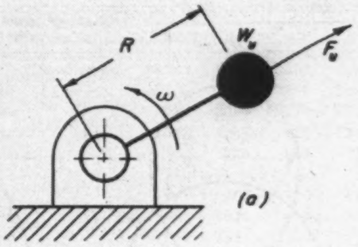

Fig. 1 — Sketches illustrating unbalanced force resulting from rotation of crank throw, (a), and method of counterbalancing rotational unbalance by adding weight 180 degrees from crank as in (b)

Balancing Crank Mechanisms

By C. R. Freberg*

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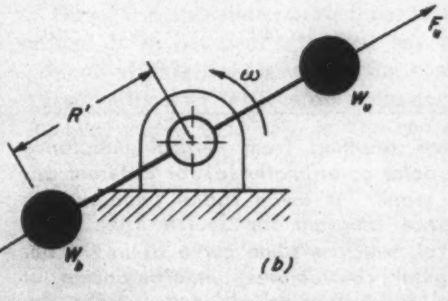


WHEN a reciprocating engine, compressor or similar machine is in the design stage, proper attention must be given to providing a sufficient balance of the running gear. Required accuracy of the balance depends partly on the class of machine being designed. An inexpensive, low-speed machine used in a noisy place may be acceptable even if quite unbalanced. A high grade machine intended for long service and for use in quiet surroundings requires much better balance.

Perfect balance of a running gear can be obtained only by complicated gear or lever mechanisms which operate off the crankshaft. However, sufficient balance is usually obtained by use of fixed counterweights. These weights are located opposite the crank and give an average balance for one revolution. Part of the time the system is overbalanced and part of the time it is underbalanced. This is a result of the connecting rod and the piston motion which is reciprocating and variable while the counterbalancing forces are rotational and constant.

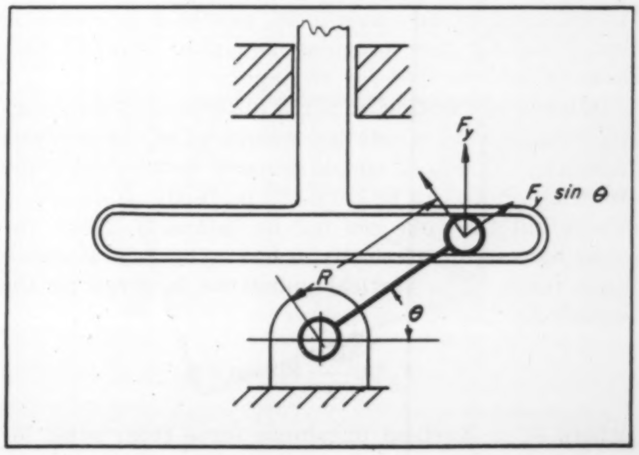
BALANCING THEORY: Conventionally, a mechanism is balanced from an analysis of its harmonics. Approximations which utilize only the first harmonic are often used with sufficient accuracy. However, most engineers are satisfied with using a certain percentage of the reciprocating weight at the crankpin. The total unbalance figured on this basis is then counterweighted.

The procedure presented in this article shows a simple method of combining the effects of single cylinders and obtaining a definite picture of the balance effects including the significant harmonics. Balancing of only one crank will be considered so that a rotating unbalance can be balanced by a counterweight located directly opposite the unbalance. In *Fig. 1a* the unbalance W_u produces an unbalance force

$$F_u = \frac{W_u}{g} R\omega^2$$

where F_u = unbalance force, lb; W_u = weight of rotating body, lb; g = gravitational acceleration constant, 386 in. per sec^2; R = distance from center of

Fig. 2—Unbalance of yoke cannot be balanced by rotating counterweight since yoke moves only vertically and has no horizontal unbalance force



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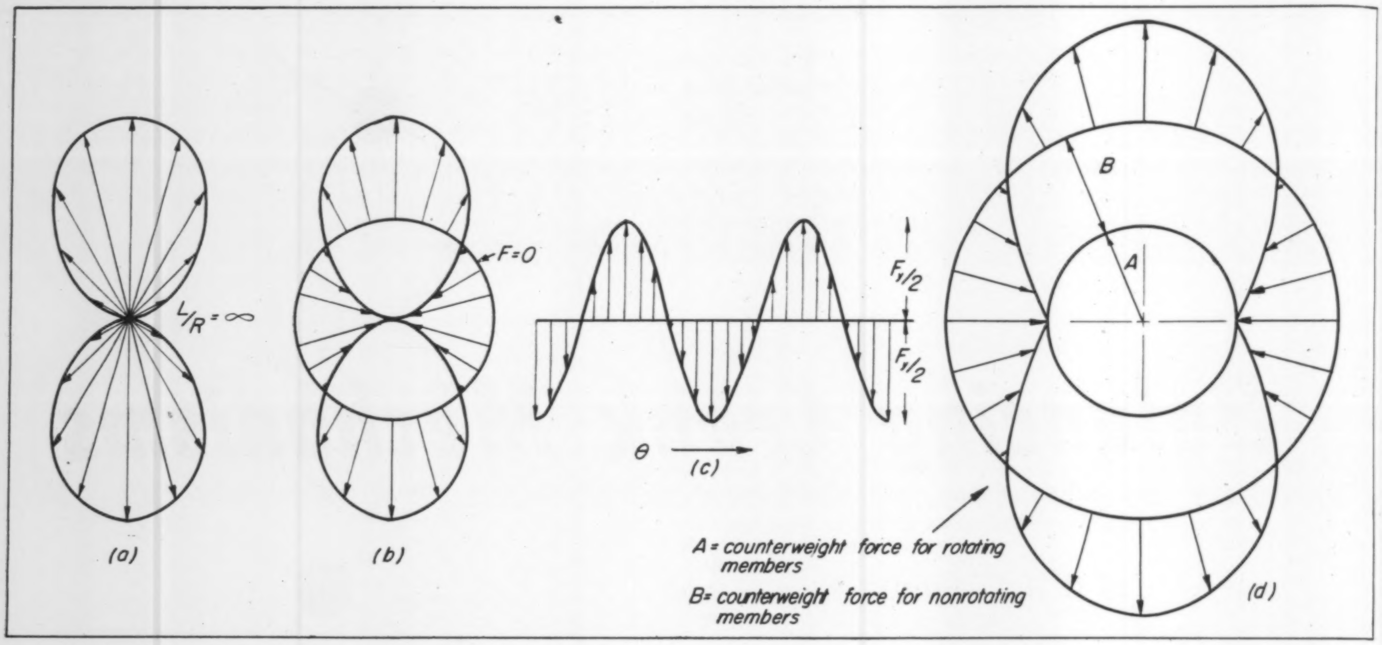


A = counterweight force for rotating members

B= counterweight force for nonrotating members

Fig. 3—Radial force resulting from vertical unbalance of yoke plotted on polar co-ordinates (a) for different angular positions of crank. If mean radial unbalance is compensated, balance diagram for Scotch Yoke is as shown in (b). In (c), which is same curve as in (b) but plotted on rectangular co-ordinates, underbalancing at end of stroke and overbalancing at center stroke are shown. Balance diagram (d) gives final condition as sum of balance for rotating weight plus average balance for nonrotating weight

gravity to center of rotation, in.; ω = angular velocity, rad per sec = $2\pi N/60$ and N = rotational speed, rpm.

In like manner, when a balance weight W_b is added opposite W_u, as shown in *Fig.* 1*b*,

$$F_b = \frac{W_b}{g} R'\omega^2$$

where F_b = balance force, lb; and R' = distance from center of gravity of balance weight to center of rotation, in. For balance, F_b must equal F_u. This leaves the condition

$$W_u R = W_b R' \text{ or } R' = \frac{W_u}{W_b} R$$

which indicates that a certain rotating unbalance may be balanced by any weight W_b provided its radius is calculated by the foregoing equation. Perfect balance is then secured for all angular positions.

With linear motion, it is not possible to secure complete balance by a rotating weight as in the previous example. In *Fig.* 2 which shows a Scotch Yoke, the rotating crank can be balanced perfectly as described above but the yoke can not be balanced. Since the yoke moves only vertically, it has no horizontal unbalance force. The vertical unbalance is given by the equation

$$F_y = \frac{W_y}{g} R\omega^2 \sin\theta$$

where F_y = vertical unbalance force from yoke, lb; W_y = weight of yoke, lb; R = crank throw, in.; and θ = crank angle from the horizontal. This results from the acceleration of the yoke which is $R\omega^2 \sin\theta$. The radial force, $F_y \sin\theta$, shown in *Fig.* 2, is plotted in *Fig.* 3*a* for the different angular positions. It is the only force that can be counterweighted by a mass opposite the crank. The other component affects the torque on the crank and therefore the torque reaction on the frame. The maximum radial unbalance from the yoke is

$$F_{yr(\text{max})} = \frac{W_y}{g} R\omega^2$$

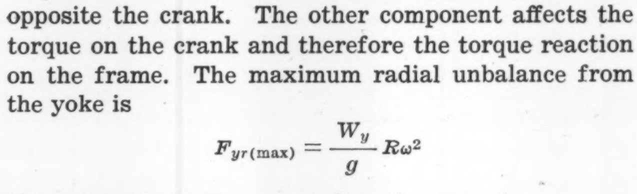
The minimum is $F_{yr(min)} = 0$ so the mean is

$$F_{yr(\text{mean})} = \frac{W_y}{2g} R\omega^2$$

If $F_{yr(mean)}$ is counterbalanced the balance diagram is as shown in *Fig.* 3*b*. This shows that at the ends of the stroke it is underbalanced by $F_y/2$ while at the center positions it is overbalanced by $F_y/2$. This can also be plotted on rectangular co-ordinates as shown in *Fig.* 3*c*.

The final balance then involves the sum of the balance for the rotating crank and pin and the average balance of the nonrotating parts. The resulting balance diagram is illustrated in *Fig.* 3*d*.

Fig. 4—Schematic piston and connecting rod with notation



Use of a connecting rod and piston instead of a yoke introduces added complications because the motion of the rod and piston depends on the proportions of the crank and the rod, that is, on the L/R ratio where L is the length of the rod between bearing centers and R is the throw of the crank. However, the analysis is basically the same as for a Scotch Yoke.

Balancing Rotating Members

First, the rotating members can be balanced perfectly. It is necessary to make a force analysis to balance the connecting rod and piston. A schematic running gear which will be used as an illustration is shown in *Fig*. 4. To simplify the problem of handling the connecting rod it is reduced to two equivalent weights, one at the crank pin and one at the wrist pin. These weights can be determined by weighing, as in *Fig*. 5, or they can be calculated by the equations

$$W_A = W \frac{B}{A + B}$$

$$W_B = W \frac{A}{A + B}$$

where W is the total weight of the rod and the other symbols are defined in *Fig*. 5. This simplification is very nearly correct dynamically.

Assuming one portion of the connecting rod rotating and the other reciprocating with the piston, the rotating part can be balanced but the reciprocating weight can only be given a mean balance. Unbalance of the piston and reciprocating portion of the rod W_B produce a force

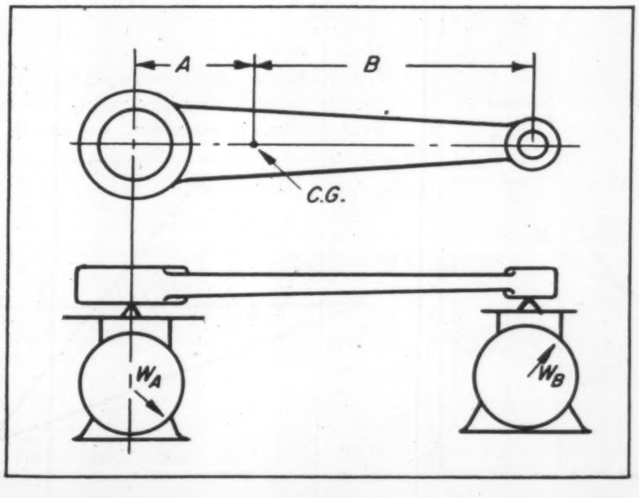
$$F_p = \frac{W_p + W_B}{g} A_p$$

where F_p = inertia force of reciprocating masses, lb; W_p = weight of piston assembly, lb; W_B = weight of reciprocating part of connecting rod, lb; A_p = acceleration of piston, in. per sec^2; and other units are as noted previously. Acceleration of the piston may be determined graphically, calculated mathematically, or taken from a table. Later paragraphs will be based on tabulated results.

TABLE I—Inertia Factors

Crank Angle Degrees	Kx10^8 L/R=2	3	4	5	6	7	8	∞
0 (Head end)	4262	3788	3551	3409	3315	3246	3193	2841
15	3735	3371	3192	3084	3013	2941	2913	2651
30	2351	2314	2270	2243	2226	2209	2190	2131
45	938	1091	1172	1221	1254	1288	1306	1421
60	61	226	318	395	443	485	512	711
75	175	9	2	16	32	49	64	190
90	947	355	190	118	81	58	44	0
105	1668	936	614	555	479	423	389	190
120	1940	1441	1229	1112	1038	988	949	711
135	1852	1740	1666	1619	1586	1564	1546	1421
150	1645	1863	1946	1989	2016	2041	2059	2131
165	1481	1892	2089	2204	2258	2341	2393	2651
180 (Crank End)	1421	1894	2131	2273	2368	2444	2506	2841

Fig. 5—Method of determining weights of rotating and reciprocating portions of connecting rod



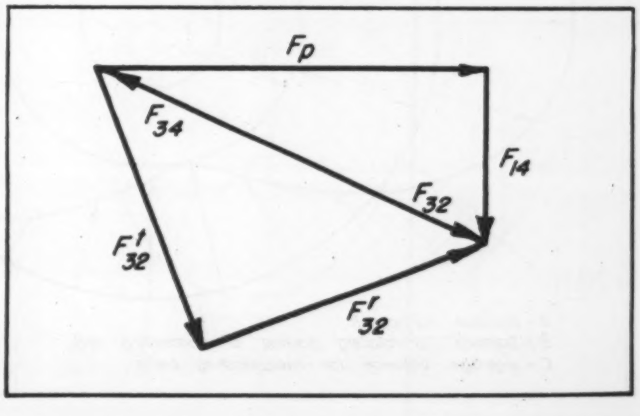
Once the unbalanced reciprocating force is determined it is necessary to find the mean radial component of this unbalance on the crank. This is done graphically with a force diagram such as *Fig*. 6. Force F_p produces a force F_{34} of the rod on the piston and a force F_{14} of the frame on the piston. Force F_{34} carries through the connecting rod to the crank as F_{32}. This has radial and tangential components as shown. The radial component is the only part which can be balanced by a fixed counterweight. The tangential component, however, does affect the torque diagram and will influence the torque reaction and, therefore the shaking force.

Balancing Reciprocating Parts

The mean value of the maximum and minimum radial force can be used to determine the balance needed for the reciprocating parts. To this must be added the balance from the rotating crank plus the balance from the rotating portion of the connecting rod. The final balance diagram is shown in *Fig*. 7. This diagram is similar to that for a Scotch Yoke except for the effects of angularity which produces a higher inertia force at the head end than at the crank end of the stroke. There is also a slight shift in the points of zero inertia force. Each L/R ratio and each combination of masses gives a different diagram.

SIMPLIFIED METHOD: If the foregoing procedure

Fig. 6—Force diagram to find mean radial component of unbalanced reciprocating force



were followed for each new design, it would involve considerable work. It is possible, however, to make up a table of inertia balance factors for different L/R ratios such that the necessary balance may be determined easily and quickly with no involved calculations or graphical analysis.

The basis of this table of factors is the piston acceleration. The acceleration of the piston in *Fig.* 4 is

$$A_p = 0.657\, RN^2 \left(\cos\theta + \frac{[(L/R)^2 - 1] \cos 2\theta + \cos^4\theta}{\left(\dfrac{L}{R} \cos\phi \right)^3} \right)$$

where R = crank throw, inches; ϕ = rod angle to cylinder centerline; and θ = crank angle, measured from cylinder centerline. Since $\sin\phi = R/L \sin\theta$, it is apparent that the term inside the parenthesis depends only on θ and L/R so that a table of factors can be made for these variables. L. B. Smith of Hampton, Va. has compiled these factors in his booklet *Displacement, Velocity, and Acceleration Factors for Reciprocating Motion* and included the constant with them so that the acceleration is determined by the equation

$$A_p = RN^2K'$$

where K' is the acceleration factor for a particular L/R ratio and for a particular crank angle.

Determining Radial Force

The inertia force of the reciprocating weight can be determined from this factor by the equation

$$F_p = \frac{W_p}{g} RN^2K'$$

where W_p is the weight of the reciprocating parts. Obviously too, it is possible to determine a relation between this force and the radial component on the crank which depends only on the L/R ratio and the crank angle. This relation, from *Fig.* 8, is

$$F_R = F_p \left(\frac{\cos(\phi + \theta)}{\cos\phi} \right)$$

where $\sin\theta = (L/R) \sin\phi$.

It is therefore possible to set up an expression for the radial force so that

$$F_R = \frac{W_p}{g} RN^2 \frac{(2\pi)^2}{60} \left(\cos\theta + \frac{[(L/R)^2 - 1] \cos 2\theta + \cos^4\theta}{\left(\dfrac{L}{R} \cos\phi \right)^3} \right) \left(\frac{\cos(\phi + \theta)}{\cos\phi} \right)$$

$$= W_pRN^2K$$

where K = inertia factor depending only on θ and L/R but including some constant; W_p = weight of reciprocating parts, lb; and R = crank throw, in.

Values of K for different L/R ratios and crank angles are given in TABLE I. When plotted they are as shown on polar co-ordinates in *Fig.* 9. These curves show the effect of the angularity on the radial com-

TABLE II—Inertia Factors

Crank Angle Degrees	Kx10^5 No. 1 cyl.	Kx10^5 No. 2 cyl.	Kx10^5 Total
0 (Head End)	1221 (45 degrees)	1221 (–45 degrees)	2442
15	395	2243	2638
30	16	3084	3100
45	118	3409	3527
60	555	3084	3639
75	1112	2243	3355
90	1619	1221	2840
105	1989	395	2384
120	2204	16	2220
135	2273	118	2391
150	2204	555	2759
165	1989	1112	3101
180 (Crank End)	1619	1619	3238

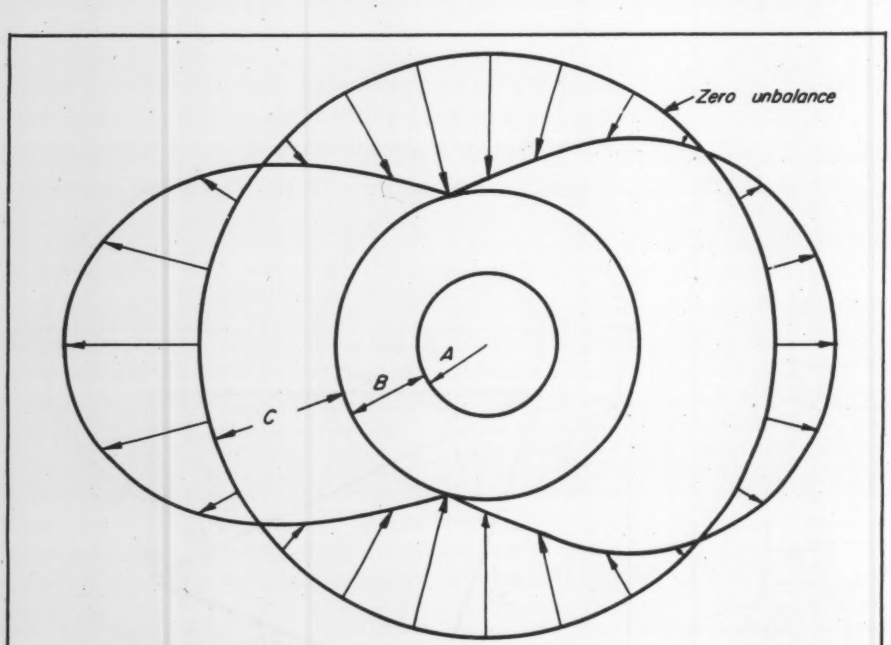

Zero unbalance
A
B
C
A = balance for crank
B = balance for rotating portion of connecting rod
C = average balance for reciprocating parts

Fig. 7—Left—Final balance diagram showing balance needed for reciprocating parts, rotating crank and rotating part of rod

Fig. 8—Below—Relationship between inertia force of reciprocating mass and radial component on crank

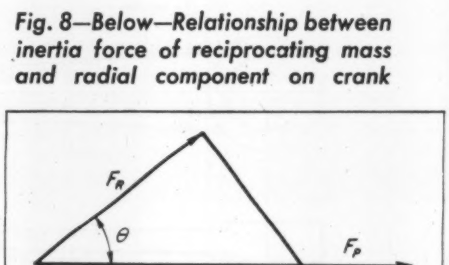


TABLE III—Inertia Factors

Crank Angle Degrees	No. 1 cyl. (Kx10⁸)	No. 2 cyl. (Kx10⁸)	No. 3 cyl. (Kx10⁸)	Total
0 (Head End)	395 (60 degrees)	3409 (0 degrees)	395 (−60 degrees)	4199
15	16	3084	1221	4321
30	118	2243	2243	4604
45	555	1221	3084	4860
60	1112	395	3409	4916
75	1619	16	3084	4719
90	1989	118	2243	4350
105	2204	555	1221	3980
120	2273	1112	395	3780
135	2204	1619	16	3839
150	1989	1989	118	4096
165	1619	2204	555	4378
180 (Crank End)	1112	2273	1112	4497

ponent of the reciprocation unbalance. Values of the inertia factor K for intermediate values of L/R can be taken from *Fig.* 9. The unbalance force is then

$$F = W_p N^2 R K$$

The unbalance in lb-in. can be calculated from the equation

$$F = \frac{WR}{g}\left(\frac{2\pi N}{60}\right)^2$$

by rearranging so that

$$WR = \frac{Fg3600}{N^2\,4\pi^2} = \frac{35{,}200F}{N^2}$$

where W = balance weight; R = radius to center of gravity of balance weight; and F = unbalance force.

The usefulness of these data extends to the multi-cylinder units as well as to single cylinder units by considering each crank independently. The following examples illustrate the usefulness of the system:

EXAMPLE 1. Determine the balance of a single cylinder engine whose crank arm is 2 in. and whose rod is 8 in. long. Unbalance of the two crank cheeks is 5 lb-in. and unbalance of the crank pin is 1.5 lb-in. The rotating end of the rod weighs 12 oz and the reciprocating end weighs 4 oz. The piston, wrist pin, and rings weigh 4 lb. What is the mean unbalance condition?

Solution: The L/R ratio is 4 so the maximum unbalance factor is 3551 × 10^{-8}, from TABLE I, and the minimum is 0. The mean unbalance from the reciprocating parts will be

$$F_1 = 4.25\ (2)\ (N)^2 \frac{3551}{(2)10^{-8}} = \frac{1.51}{10^4} N^2$$

At 1000 rpm this would be F_1 = 151 lb mean or 302 lb maximum, equivalent to an unbalance of

$$WR = \frac{35{,}200F}{N^2} = \frac{35{,}200(151)}{1000^2} = 5.32 \text{ lb-in.}$$

The rotating portion of the connecting rod unbalance is given by

$$U = WR = \frac{12}{16}\ (2) = 1.5 \text{ lb-in.}$$

The mean reciprocating unbalance = 5.3 lb-in.; crank

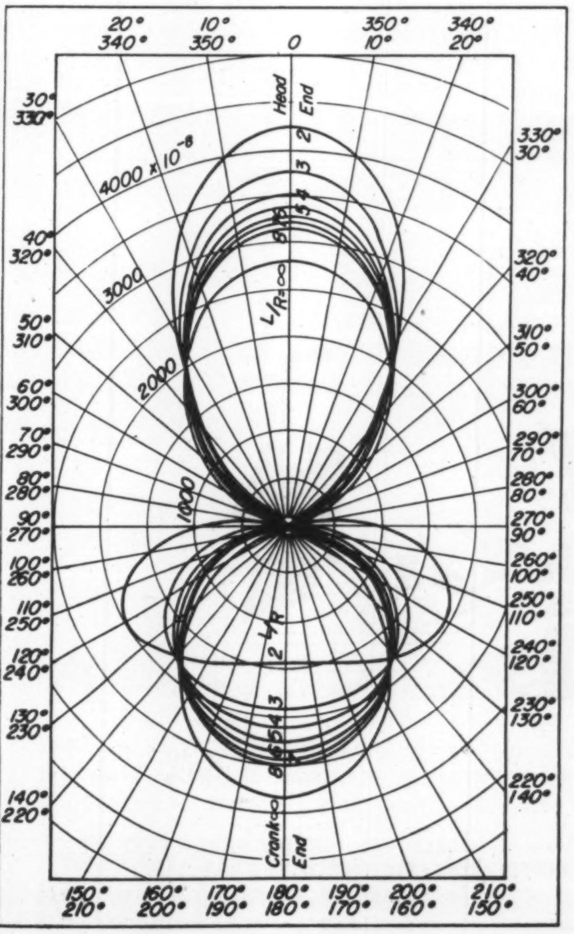
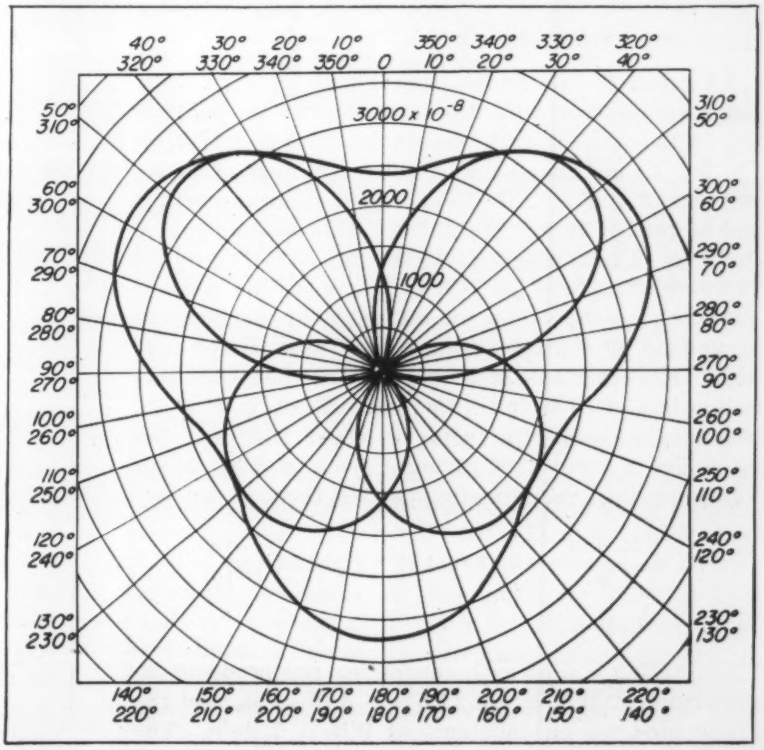


Fig. 9—Left—Values of inertia factors for various L/R ratios shown plotted on polar co-ordinates. Values of K for intermediate L/R ratios may be obtained by interpolation

Fig. 10—Below—Inertia factors for combination of two cylinders 90 degrees out of phase. Diagram is symmetrical about vertical centerline



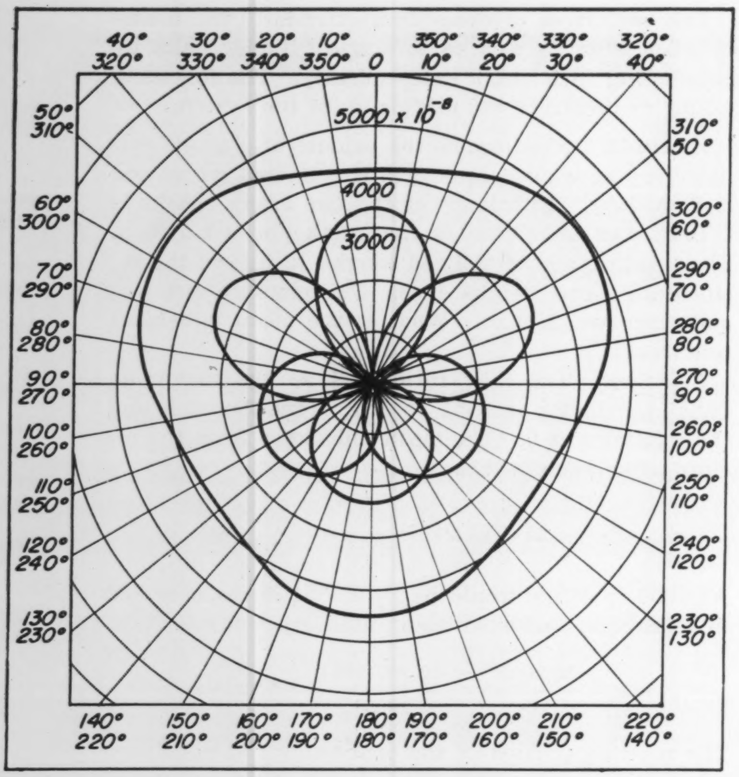


Fig. 11—Total inertia factors resulting from combination of three cylinders 60 degrees apart

unbalance = 6.5 lb-in.; rotating portion of the rod unbalance = 1.5 lb-in.; and total mean unbalance = 13.3 lb-in. This is the amount of unbalance the counterweight must counteract. When the crankshaft is balanced prior to assembly it is customary to add an equivalent weight to the crankpin to replace the rod and piston while balancing. This problem would require that a weight of 5.3/2 + 1.5/2 or 3.4 lb be added by a weight on the crankpin. Care should be taken to keep the center of gravity of this weight at the center of the crank pin.

EXAMPLE 2. Determine the balance of a two-cylinder compressor with the cylinders at 90 degrees and with equal weight pistons; $R = 1\frac{1}{2}$ in., $L = 7\frac{1}{2}$ in. Crank unbalance = 7 lb-in.; weight of rotating end of rod = 2 lb 8 oz; weight of reciprocating end of rod = 14 oz. Weight of piston assembly = 4 lb 12 oz. Crank speed = 1800 rpm.

Solution: Since the two cylinders are 90 degrees out of phase, the values for the unbalance factors can be shifted 90 degrees. This gives TABLE II for $L/R = 5$. The other side is symmetrical so that when this factor is plotted it takes the form shown in *Fig.* 10. The maximum inertia factor is about 3640 and the minimum is about 2220 giving a mean of 2930. Mean unbalance from reciprocating parts is then

$$WR = \frac{35{,}200F}{N^2} = 35{,}200\ (4.75 + 0.88)\ 1.5\left(\frac{2930}{10^8}\right)$$

$$= 8.7 \text{ lb-in.}$$

The rotating end of each connecting rod produces an unbalance of $WR = 2.5\ (1.5) = 3.75$ lb-in., and the crank produces an unbalance of $WR = 7$ lb-in. The total equals 23.2 lb-in. and this must be counterweighted. For machine balancing a weight of 8.7/1.5 + 2(3.75)/1.5 or 8.1 lb must be fastened to the crank pin.

It may be observed that the reciprocating portion of the unbalance requires 5.8 lb which is approximately equal to the weight of the reciprocating parts for one cylinder, 5.63 lb. This is in agreement with an approximation often used based on balancing the first harmonic in the usual method of analysis.

EXAMPLE 3. The same problem as in Example 2, except that 3 cylinders, 60 degrees apart are assumed. Pistons are all of the same weight and are driven from a single crank. Rods all have the same weights and weight distributions.

Solution: Half the crank positions can be calculated as in TABLE III and plotted as in *Fig.* 11.

The maximum value of unbalance is 4916 and the minimum is 3780 so that the average is 4348. Mean value of unbalance from the reciprocating parts is

$$WR = \frac{35{,}200}{N^2}\ (4.75 + 0.88)\ 1.5\ \frac{4348}{10^8}\ N^2 = 12.9 \text{ lb-in.}$$

Balancing weight required on the crank pin would be

$$W = \frac{12.9 + 3\ (3.75)}{1.5} = 12.6 \text{ lb}$$

This system would be better balanced if the three cylinders were spaced 120 degrees apart. The weight of the middle cylinder might be increased some to improve the balance. This would increase the magnitude of its component by the ratio of the weights. The same would hold true if the rods had different weights. When different cranks are used it is possible to balance each crank individually or to combine their results vectorially.

B.GLIBWIKET
CHIEF
ENGINEER
TRAG

"MR.GLIBWIKET PUZZLES ME . . .TODAY HE CALLED ME HIS LITTLE CO-EFFICIENT OF EXPANSION!"

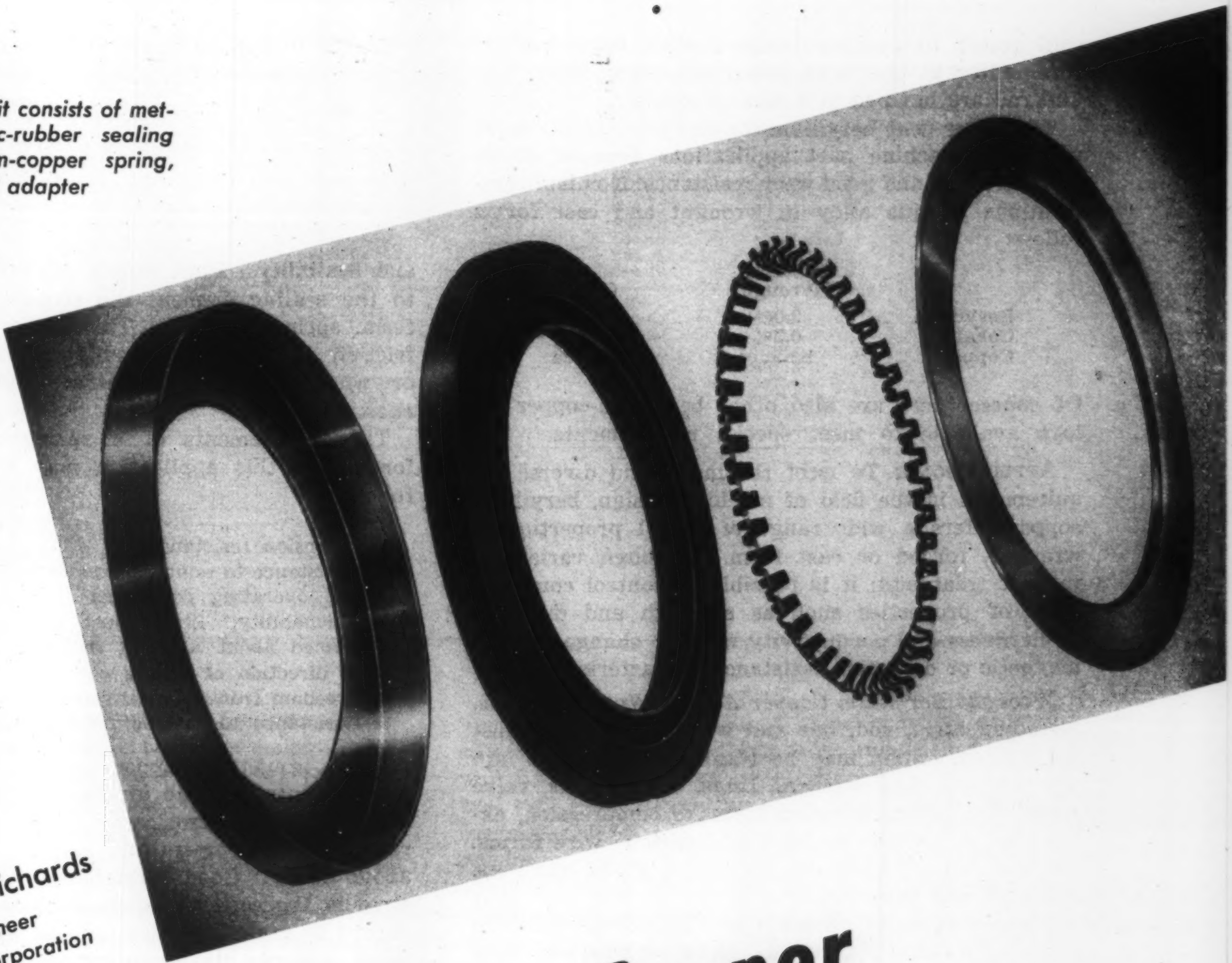


Fig. 1—Oil-seal unit consists of metal case, synthetic-rubber sealing member, beryllium-copper spring, and metal adapter

By John T. Richards
Design Engineer
The Beryllium Corporation
Reading, Penna.

What Beryllium Copper Offers the Designer

Age-hardenable alloy—wrought or cast—has many unique properties and characteristics

ALTHOUGH beryllium copper is most familiar to the designer as a spring material, it is finding increased use in other machine components. High strength, good electrical conductivity and good corrosion resistance—properties which have led to its adoption in spring design—are also of value in mechanical parts.

Since beryllium copper is an age-hardenable alloy, parts are formed or machined in a relatively soft condition, then given a low-temperature heat treatment to produce maximum properties. This process offers the engineer flexibility of design, so that severely formed and intricate machine parts may be heat-hardened to strength and hardness values otherwise unobtainable. For example, strip in the solution-annealed condition may be formed readily to a sharp radius in any direction. A heat treatment of 3 hours at 600 F will increase the tensile strength from 65,000 psi with 45 per cent elongation, to 175,000 psi. Higher final values are obtainable in strip cold rolled to various tempers with some loss of formability in the unhardened condition. Wire, bar and rod are handled in a similar manner.

The 2 per cent beryllium-content alloy is the most useful in machine part applications because of its high strength and good wear resistance. Nominal compositions of this alloy in wrought and cast forms follow:

	Wrought	**Cast**
Beryllium	2.0%	2.0%
Cobalt	0.3%	0.5%
Copper	balance	balance

Of course there are also other beryllium-copper alloys available to meet special requirements.

APPLICATIONS: To meet the many and diverse requirements in the field of machine design, beryllium copper offers a wide range of useful properties in wrought, forged or cast form. Through variations in heat treatment, it is possible to control combinations of properties such as strength and ductility or hardness and conductivity with no change in nonmagnetic or corrosion resistance characteristics.

Wrought Beryllium Copper Alloys: Wrought forms, including strip, rod, bar and wire, find the greatest application. Strip may be blanked and formed into flat springs, clips, washers, rings, seals, shims, valve reeds, etc. Wire is coiled to make compression, extension and torsion springs, and various wire forms. Bar and rod are machined into cams, gears, bushings, bearings and fasteners.

Various types of oil seals are used in machines to provide bearing protection. A spring-loaded, self-contained oil seal is not only required to seal the lubricant in a bearing; it must also resist the corrosive action of water which may enter the bearing through condensation, leakage or entrainment. In addition, the unit must seal against and be resistant to oil, grease, dirt, mud, dust and other foreign matter. The four component parts of such a seal are shown in ***Fig.*** 1, while ***Fig.*** 2 shows a typical application.

To obtain maximum sealing efficiency, the spring, a vital part of the unit, must have extreme sensitivity and flexibility. Each finger independently transmits to the sealing element the required light, but uniform, spring pressure. This action provides a low-friction bearing seal on high or low-speed shafts, or where considerable lateral shaft movement is encountered.

Fig. 2—Below—Piston-pump drive showing location of oil-seal unit. Beryllium-copper spring component provides required spring properties plus excellent corrosion resistance

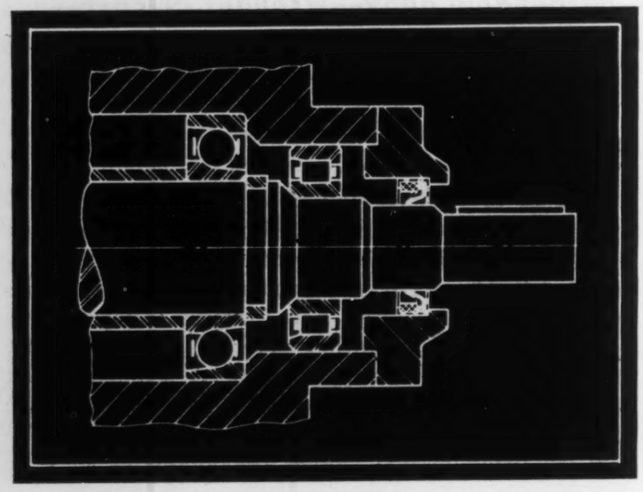


TABLE I—**Typical Constants of Beryllium Copper**

Density (lb/cu in.)	0.297
Specific Gravity (gm/cu in.)	8.23
Melting Range (deg F)	1590-1750
Specific Heat (cal/gm/deg C) (30 to 100 C)....	0.10
Magnetic Properties	nonmagnetic
Poisson's Ratio	0.33

The requirements of a spring material suitable for use in this application may be summarized as follows:

1. Corrosion resistance
2. Resistance to temperatures encountered under normal operating conditions
3. Formability. Strip must be capable of being formed about a small radius with bend parallel to direction of rolling
4. Freedom from internal stress
5. Resistance to fatigue from repeated flexing.

Since beryllium copper strip meets all of these requirements, it is an ideal material for the application. It resists corrosion by water, steam and oil and retains room-temperature spring properties up to about 300 F. Good formability across or along the strip in the softer tempers permits bending without regard to grain direction, and subsequent heat treatment produces maximum spring properties. Materials such as brass and bronze, which derive all their strength from cold work, have low spring properties in the tempers soft enough to permit severe bending across the grain. The age-hardening treatment of beryllium copper not only produces high elastic and endurance strength but can also be used to relieve undesirable residual stresses, thereby insuring uniform pressure in the spring fingers.

Excellent for Nonmagnetic Ball Bearings

Beryllium copper ball bearings resulted from a wartime search for a suitable nonmagnetic bearing material. Although a number of the available alloys offered nonmagnetability, they did not respond to hardening or were not readily machined, or required unusually long heat treating cycles. Even though

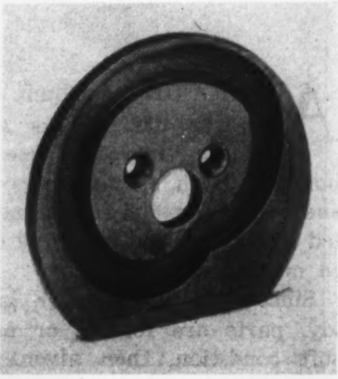


Fig. 3—Right—Precision-cast face cam used in teletype machine. This beryllium-copper part lasted longer than steel and cost 33 per cent less

Table II—Typical Mechanical Properties of Beryllium Copper

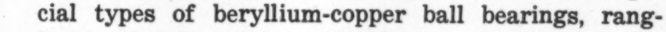
Form and Temper	Tensile Strength (psi)	Elongation in 2 in. (%)	Rockwell Hardness		
Strip					
Annealed	60- 80,000	35-50	B45-65	30T46 -60	15T75 -81.5
Annealed, heat treated	165-180,000	5-10	C36-41	30N56 -60.5	15N78.5-81
1 No. Hard	73- 78,000	10-35	B66-85	30T60.5-73.5	15T82 -88
1 No. Hard, heat treated	175-190,000	4-7	C38-42	30N57.5-61.5	15N79.5-81.5
2 No. Hard	80-100,000	5-15	B86-93	30T74 -78	15T88.5-91
2 No. Hard, heat treated	185-200,000	2-5	C39-43	30N58.5-62	15N80 -82
4 No. Hard	95-120,000	2-6	B94-99	30T78.5-81.5	15T91.5-92.5
4 No. Hard, heat treated	190,205,000	1-3	C40-44	30N59.5-63.0	15N80.5-82.5
Rod					
Annealed (0.020 to ¼-in.)	60- 85,000	35-50	B55-80	30T53-68	
(over ¼-in.)	60- 85,000	35-50	B55-80	30T53-68	
Annealed, heat treated (0.020-in. and over)	165-180,000	3-8	C36-41	30N56-60.5	
Cold worked (0.020 to ¼-in.)	90-115,000	10-25	B88-95	30T73-79	
(over ¼ to ¾-in.)	95-120,000	10-25	B90-97	30T74-80.5	
(over ¾-in.)	80-100,000	10-25	B80-90	30T68-76	
Cold worked, heat treated (0.020 to ¾-in.)	185-215,000	2-5	C39-44	30N58-63	
(over ¾-in.)	165-190,000	3-6	C36-41	30N56-60.5	
Wire					
Annealed	60- 80,000	35-50			
Annealed, heat treated	165-180,000	5-10			
1 No. Hard	90-110,000	10-25			
1 No. Hard, heat treated	175-190,000	4-8			
2 No. Hard	100-135,000	5-10			
2 No. Hard, heat treated	180-200,000	2-6			
3 No. Hard	125-145,000	2-5			
3 No. Hard, heat treated	185-210,000	2-4			
4 No. Hard	135,155,000	0-2			
4 No. Hard, heat treated	190-220,000	1-3			

beryllium copper would not harden to the same degree as bearing steel, its moderate hardness coupled with its nonmagnetic properties made it satisfactory for numerous applications. In addition, its resistance to many corrosives including salt water, together with relatively high nonsparking tendencies, suggested other fields of application.

Through recognition of the design limitations imposed by the lower hardness of beryllium copper (Rockwell C42) as compared to bearing steel (Rockwell C60), beryllium copper bearings of lower load capacities successfully met exacting wartime needs. Early tests revealed that higher capacities than indicated by the hardness differential were possible. Good fatigue resistance of the races might have been a factor.

This development has expanded, so that there are now in service radial, pivot, angular-contact and special types of beryllium-copper ball bearings, ranging in size from 5 mm (0.1968 in.) outside diameter up. The races and balls of these bearings are machined by precision methods from unhardened (Rockwell B75-90) rod. Parts are then hardened to Rockwell C42 by heat-treating for 2 hours at 600 F. Corrosion-resistant and nonmagnetic properties make beryllium copper ball bearings especially suited for compass tables, electronic devices, navigational instruments, fishing reels and marine equipment; while the relative nonsparking characteristic suggests use in locations made hazardous by the threat of fire or explosion.

Fig. 4—Below—Assorted beryllium-copper parts cast by investment method, showing intricate detail possible



Material selection plays an important role in the design of the various types of cams found in modern machinery. Since it is easier to replace cam follower rolls than the cam itself, wear should be limited to the rolls. Inasmuch as operating conditions vary considerably from one application to the next, no one material has been found best for all requirements.

Sufficient data has been accumulated from actual installations, both successful and unsuccessful, to point out the advantages and limitations of beryllium copper in this field. At the present time, this alloy is finding its greatest use in follower rolls, although a number of beryllium copper cams, especially small, precision-cast units, are in use. Beryllium copper

Fig. 5—Below—Precision-cast sight used in navigational equipment. Beryllium copper offers required corrosion resistance and permits as-cast tolerance of plus or minus 0.001-inch on slot width

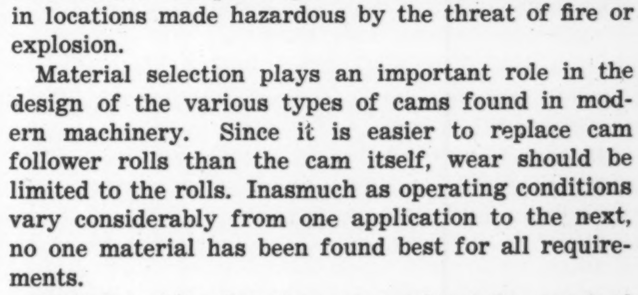


TABLE III—**Typical Electrical and Thermal Properties of Beryllium Copper**

	Annealed		Cold Worked	
	Heat Treatable	**Heat Treated**	**Heat Treatable**	**Heat Treated**
Electrical properties				
Conductivity (% I.A.C.S.)—20 C	18–20	25–29	15–17	22–25
Resistivity (microhm centimeters)—20 C	9.07	6.38	10.78	7.19
200 C	10.87	7.87	12.72	8.35
Temperature Coefficient (20 to 200 C)	0.0011	0.0013	0.0010	0.0009
Thermal Properties				
Conductivity (cal/sq cm/cm/sec/deg C)—20 C	0.21	0.30	0.16	0.27
200 C	0.25	0.34	0.20	0.33
Temperature Coefficient (20 to 200 C)	0.0011	0.0007	0.0014	0.0012

apparently gives best results in critical applications where conditions such as shock, light lubrication, rapid acceleration or deceleration, and intermittent motion, exist. Under these conditions good wear has been reported for beryllium copper rolls used with barrel, peripheral or face cams of cast iron, Meehanite or air-hardened steel.

The following case is typical of a cam application in which beryllium copper aided in the solution of a design problem. To provide the required indexing action in a certain machine, cams are employed to translate rotary motion into Geneva motion. The camshaft rotates continuously at 300 rpm, while the driven shaft turns intermittently, being at rest 50 per cent of the time. Each of the six cam rolls are subjected to drastic speed fluctuations—from zero to maximum to zero—fifty times per minute. Sliding and skidding between roll and cam face combined with light lubrication of the periodic dot type are likely to cause serious wear of cam or roll or both. Beryllium copper is now the standard roll material in this application, since exhaustive tests have indicated that this alloy gives longer life with the air-hardened steel cam than the aluminum bronze or carburized steel rolls previously tried.

In this application, the beryllium copper rolls are machined from hot-rolled and solution-annealed rod, then heat treated for three hours at 600 F in a circulating air furnace to produce maximum hardness. Finally, inside and outside diameters are finish ground to size. Best results are obtained from rod having a moderately fine-grained structure.

TABLE IV
Typical Design Stresses of Beryllium Copper

Design Stresses (lbs/sq in.)	**Annealed and Heat Treated**	**Cold Worked and Heat Treated**
Tensile Properties—Strip and Rod		
Proportional Limit (0.002% offset)	70– 80,000	90–105,000
Elastic Limit (0.002% permanent set)	75– 85,000	95–110,000
Yield Strength (0.01% offset)	85– 95,000	110–120,000
(0.20% offset)	130–150,000	160–180,000
(0.50% strain)	85– 95,000	90–100,000
Elastic Modulus (20 C)	19,000,000	19,000,000
Thermoelastic Coefficient	0.00035	0.00035
Torsional Properties—Rod		
Proportional Limit	....	65– 70,000
Elastic Modulus (20 C)	7,300,000	7,300,000
Thermoelastic Coefficient	0.00033	0.00033
Fatigue—Strip		
Reverse bending	37– 45,000	40– 48,000
Fatigue—Rod		
Rotating beam	40– 50,000	45– 60,000
Fatigue—Wire		
Rotating arc	....	45– 60,000
Compression spring	....	45– 60,000

Cast Beryllium Copper Alloys: Although all of the foregoing applications are formed or machined from wrought material, similar and other beryllium copper machine parts can be readily cast. Relatively low pouring temperatures together with good fluidity in the molten state aid in producing parts by sand, permanent-mold, pressure, plaster or lost-wax casting methods. With age-hardening, beryllium copper castings develop the same properties eas wrought forms.

Of particular significance in recent years has been the development of precision castings, *Figs.* 3, 4 and 5, through lost-wax or investment casting techniques. Excellent casting characteristics coupled with good hardness and wear resistance in the age-hardened condition, make beryllium copper especially adaptable to this process. Advantages include flexibility of design by combining several subassemblies, low-cost tooling, and accurate reproduction of detail in small parts without machining. Furthermore, the denser structures obtained by lost-wax as compared to sand casting, result in higher strengths.

Particularly Adapted to Investment Casting

In spite of the higher initial cost, finished parts are frequently cheaper in beryllium copper than in steel. Since most investment-cast parts are relatively small, material costs are practically negligible. The lower pouring temperature of beryllium copper reduces production costs through easier handling and fewer steps in the preparation of the investment. The higher fluidity of beryllium copper offers such design advantages as smoother surfaces, more accurate dimensions and better detail. Without machining, therefore, it is possible to produce knife edges, narrow slots and long, thin cores. In addition, beryllium copper compares favorably in hardness and wear resistance with mild and stainless steels.

Compared to other nonferrous alloys, precision-cast beryllium copper parts are harder and give longer life through increased wear resistance. Beryllium copper should be specified when strength, hardness and resistance to wear are of primary importance.

In designing for investment casting, tolerances should be liberal to keep costs low. When necessary, however, tolerances as low as 0.001-inch per inch can be maintained on correctly designed beryllium copper parts. Minimum wall thicknesses range from 0.030 to 0.050-inch, depending upon section area and permissible taper. Although ribs are preferred where added strength is essential, sections up to ¼-inch thick can be handled. For critical applications, it

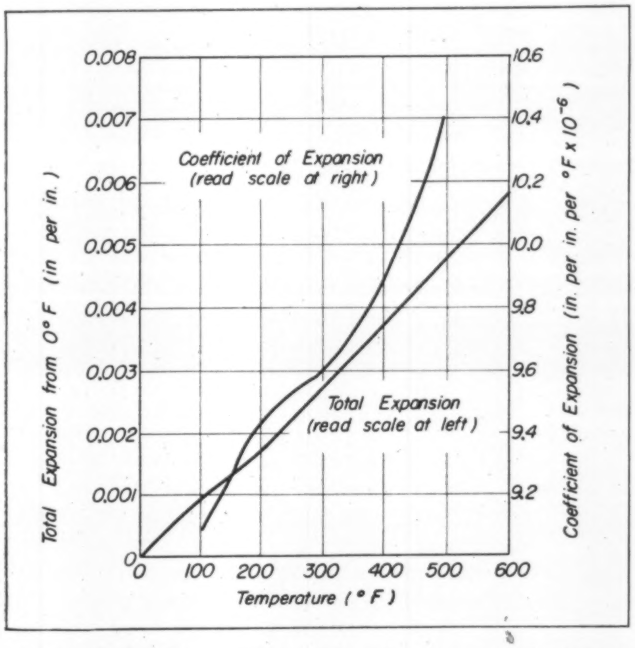


Fig. 6—Thermal expansion of beryllium copper fully heat treated from annealed or cold-worked tempers

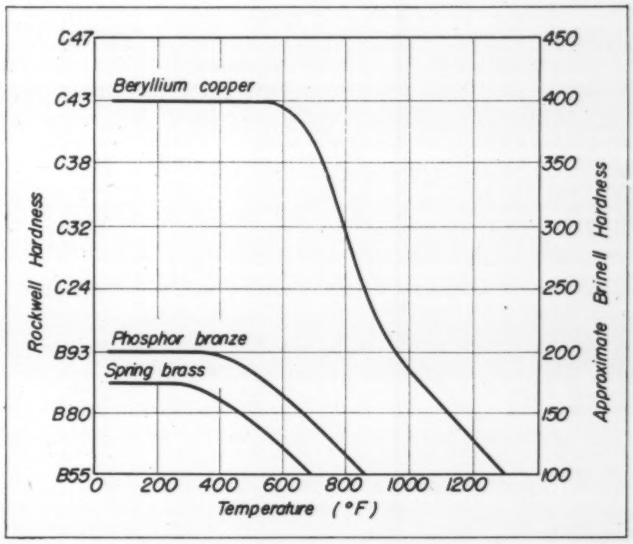


Fig. 7—Loss of hardness resulting from one hour at various elevated temperatures. Beryllium copper fully heat treated from cold-worked condition. Brass and bronze in cold-worked condition

generally is advisable to finish-grind, ream or tap by machine, rather than depend upon as-cast tolerances or threads.

Fabricating and Heat-Treating

PRESSWORKING: Strip, in the heat-treatable tempers (annealed or 1, 2 or 4 B&S Numbers hard), is readily formed, drawn or blanked in a manner similar to phosphor bronze or spring brass. Since more desirable final properties are obtained from cold-worked tempers, it is generally advisable to use the highest temper that will withstand the required forming. Annealed or 1 B&S Number hard strip is recommended for drawn or severely formed parts, while 2 or 4 B&S Number hard material is generally used for lightly formed or flat stampings. Cadmium-plated strip may be used for added die lubrication.

In the softer tempers beryllium-copper strip has an equiaxed structure. The absence of pronounced grain directionality gives almost equal formability in all directions, permitting freedom in die layout to provide efficient utilization of strip[1]. For deep drawing, one or more intermediate anneals may be necessary.

MACHINING: With the exception of finish grinding, all machining operations should be performed with the material in the unhardened condition. Cold-worked stock is generally preferred for turning, boring or milling, while annealed material is used for drilling and reaming. Best results are generally obtained by using a moderate to high speed with a light feed.

Cutting fluids are usually required. The removal of heat is of primary importance, so that soluble oil coolants are satisfactory. In severe operations such as threading, tapping or screw machine work, additional lubrication as provided by mineral lard oils is usually required. Sulfurized oils stain beryllium copper and are not recommended unless parts can be thoroughly cleaned immediately.

In the heat-treatable condition the machinability of beryllium copper may be compared to aluminum bronze, nickel silver or phosphor bronze. Since beryllium copper work-hardens rapidly—not unlike 18-8 stainless steel—the depth of cut should always be great enough to get under the work-hardened layer. Similarly, when it may be necessary to machine parts covered with oxide scale, the depth of cut should be great enough to keep the tool buried or the oxide film should be removed by pickling prior to machining.

Although beryllium copper cannot be considered a free-cutting material as compared with leaded brass, it may be readily machined with the proper tools, speeds, feeds and cutting fluids in a manner similar to nonleaded bronze.[2]

JOINING: Beryllium copper can be successfully

TABLE V—Comparison of Several Ferrous and Nonferrous Materials

Property	Beryllium Copper	Carbon Steel	Stainless Steel 18-8	Aluminum Bronze	Phosphor Bronze
Tensile Strength (psi)	200,000	145,000	150,000	85,000	90,000
Yield Strength (0.2% offset-psi)	175,000	120,000	125,000	50,000	75,000
Elastic Limit (psi)	110,000	75,000	80,000	40,000	55,000
Fatigue Strength (psi)	45,000	55,000	51,000	34,000	26,000
Corrosion-Fatigue Strength (psi)	45,000	8,000	35,000	22,000	26,000
Hardness-Brinell (3000 kg)	410	297	313	162	185
Rockwell	C43	C32	C34	B85	B90
Electrical Conductivity (% of copper)	25	9	3	12	18

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[1] References are listed at end of article.

TABLE VI—Corrosion Resistance of Beryllium Copper

Good Resistance	Fair Resistance	Poor Resistance
Acetic Acid, cold, unaerated	Acetic Acid, cold, aerated	Acetic Acid, hot
Atmosphere, rural industrial and marine	Ammonia, dry	Ammonia, moist
	Ammonia Salts, unaerated	Ammonia Salts, aerated
Brine		
Carbonated Water	Carbon Dioxide, moist	Ammonium Hydroxide
Carbon Dioxide, dry	Chlorine, dry	Chlorine, moist or warm
Freon	Hydrochloric Acid, up to 0.1%	Chromic Acid
Fresh Water		
Gases, Fuel Hydrocarbon Refrigerant	Linseed Oil	Ferric Salts
	Magnesium Hydroxide	Hydrochloric Acid, over 0.1%
Gasoline	Milk, hot	Mercuric Salts
Hard water	Nitric Acid, up to 0.1%	Mercury
Hydrogen	Phenols	Nitric Acid, over 0.1%
Kerosene	Phosphoric Acid, unaerated	Phosphoric Acid, aerated
Lubricating Oils		
Milk, cold	Sodium Bicarbonate	Silver Salts
Natural Gas	Sodium Carbonate	Sulfur Dioxide, moist
Nitrogen	Sulfuric Acid, hot, unaerated	Sulfuric Acid, aerated
Oxygen		
Paper Mill Sulfite Solutions		Sufurous Acid
Sea Water		
Sodium Chloride Solutions		
Sodium Hydroxide		
Sulfur Dioxide, dry		
Sulfuric Acid, cold, unaerated		

soft or silver soldered; carbon, metallic, or inert-arc welded; and flash, seam, or spot resistance welded. No satisfactory process has been devised for hard brazing or gas fusion welding.

Beryllium copper is soft soldered after heat treating, since the soldering operation is carried out at temperatures below the hardening range of the material. Good results may be obtained with usual solders in conjunction with a suitable flux provided the surface is clean.

Two silver soldering methods are used:

1. Parts are furnace heated to 1450 F so that a solder that melts at 1435 F will flow through the joint area. The temperature is reduced to 1400 F to solidify the solder, after which the assembly is quenched in water followed by standard hardening heat treatment at 600 F.
2. Torch brazed with a solder that flows at 1145 F using a suitable flux and confining the heat to the joint area. Assembly can be air cooled or quenched followed by standard heat treatment at 600 F.[3]

The second procedure is easier to control and offers good results if heat times are short. Hardness readings immediately adjacent to the joint are within a few points of the maximum heat-treated hardness.

Carbon-arc and metallic-arc processes are used to repair cracks, defects or worn surfaces in castings or to join beryllium-copper parts. Although beryllium copper, silicon bronze or aluminum bronze electrodes may be used, only beryllium copper rod will give a weld material with properties that approach those of the base metal. Aluminum or silicon-bronze rods may be used for repair welding or for welding beryllium copper to dissimilar metals. No flux is required since rods are generally supplied with a protective coating that prevents the formation of beryllium oxide. To produce maximum strength, hardness and conductivity, the assembly or overlay should be annealed at 1450 F, quenched in water, cold peened and aged at 600 F.

Beryllium copper may be welded at high speeds by the inert-arc process without flux in either argon or helium atmospheres. The various resistance welding techniques including spot, seam, or flash, can be successfully employed with beryllium copper, although some loss of properties can be expected.

HEAT TREATING: To produce optimum properties, beryllium copper must be heat treated following fabrication. Approximately peak strength and hardness result from the following standard low-temperature hardening treatments:

Annealed—3 hours at 600 F
Cold worked—2 hours at 600 F

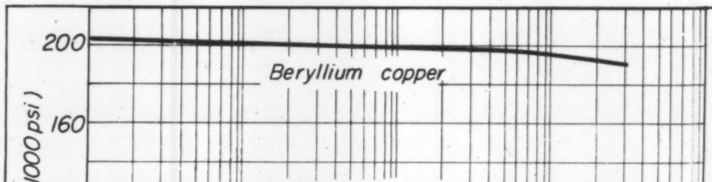
These figures indicate time at temperature and do not include time needed to bring the part to temperature. Since these values are for a circulating-air furnace, a muffle furnace will require more time; a salt bath less.

A heat treating fixture may provide the answer in applications involving close control of dimensional tolerances. The degree of control is limited only by fixture accuracy. Stress-relief-hardening, obtained by short-time, high-temperature aging, (e.g., 20 minutes at 700 F), insures fixture conformity and eliminates springback. The high degree of uniformity obtainable frequently offsets higher initial costs through reduced inspection and elimination of hand adjustment.[4]

Although age hardening in beryllium copper is actually the result of a two-step thermal treatment, the first step or solution anneal is generally provided by the mill. When it may be necessary for the fabricator to anneal beryllium copper for deep drawing or welding, satisfactory results may be obtained by annealing for one hour per inch of cross section at 1450 F, followed by immediate water quench.

CLEANING: An oxide film forms on beryllium copper when heated in an uncontrolled atmosphere into either the hardening or annealing ranges. When necessary, this scale may be removed readily by the

Fig. 8—Loss of strength with time at 390 F for cold-drawn wire. Beryllium-copper in heat-treated condition



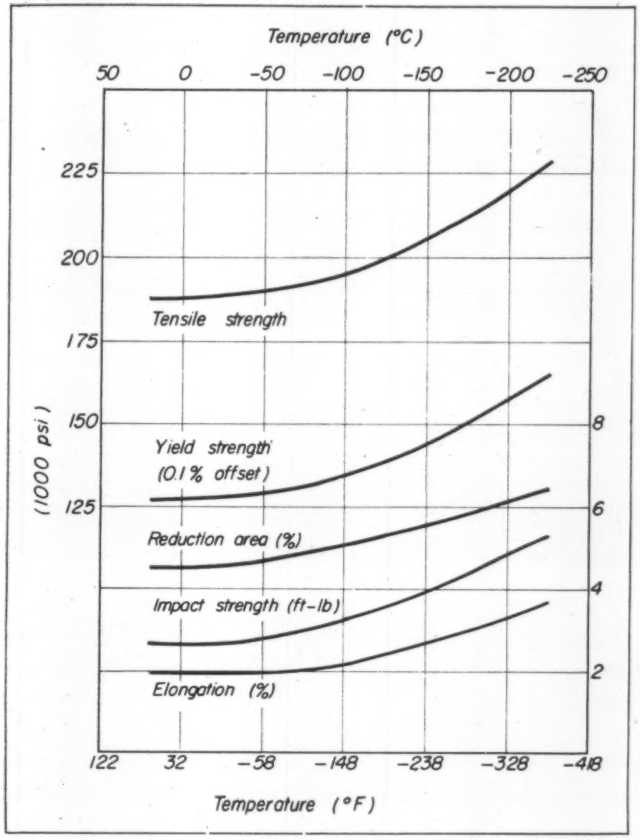


Fig. 9—Low-temperature properties of cold-worked and heat-treated beryllium copper

following pickling procedure:

1. Immerse in 20 per cent sulfuric acid solution heated to 150 F until dark scale disappears
2. Rinse in cold water
3. Bright dip in 25 per cent cold nitric acid solution for from 15 to 30 seconds
4. Rinse in hot water and dry.

Plating: Beryllium copper may be plated for appearance, added protection or die lubrication with the following metals: Cadmium, zinc, tin, chromium, nickel, silver, and gold. Parts to be plated should be free from oil, grease, dirt or scale.

Properties of Beryllium Coppers: Tables I, II, III and IV list the more important physical, mechanical, electrical and design properties of beryllium copper in strip, rod and wire forms. In these tables the term "heat treatable" refers to material in either the annealed or annealed and cold-worked conditions prior to age hardening, while "heat treated" indicates that the material has been fully hardened in accordance with heat treating procedures recommended in the foregoing. Table V offers a comparison between several ferrous and nonferrous materials. Thermal expansion data are given in *Fig.* 6.

Beryllium copper owes its selection in many applications to its good corrosion resistance coupled with high strength and hardness. In general, it has a corrosion resistance similar to other high-copper alloys. Table VI, which gives general corrosion data for direct chemical attack, is intended only as a rough guide, since corrosion rates depend upon such variables as temperature, concentration, aeration and agitation.

Season cracking, hydrogen embrittlement or dezincification apparently do not occur in beryllium copper. In addition, good resistance is offered to corrosion-fatigue which results from the combined action of corrosion and alternating stress. Note that beryllium copper has the highest corrosion-fatigue strength of any alloy listed in Table VI.

Although beryllium-copper alloys will in time stain and darken like copper when exposed to humid or sulfur-bearing atmospheres, tarnish does not affect mechanical properties. The resistance offered to warm and humid air indicates good service in tropical environments.

High and low-temperature properties are shown in *Figs.* 7, 8 and 9. *Fig.* 7 indicates that there is no loss of hardness in beryllium copper up to 550 F. *Fig.* 8 illustrates the loss of strength with time at 390 F. For best results, some allowance should be made in design stresses when operating temperatures exceed 300 F. Low-temperature properties are given in *Fig.* 9. Retention by beryllium copper of its ductility at subzero temperatures prevents impact strength reduction or low-temperature embrittlement.

The author is pleased to acknowledge the assistance of The Garlock Packing Co., Miniature Precision Bearings and Arwood Precision Casting Corp. in providing data used in this article.

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TRAG
SP
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"OKAY.... YOU'RE A MECHANICAL GENIUS.... LET ME SEE YOU GET HIM OUT OF THAT!"

Oscillating Pilot Controls Valve

By W. J. Schupner
Design Engineer
Hanna Engineering Works
Chicago

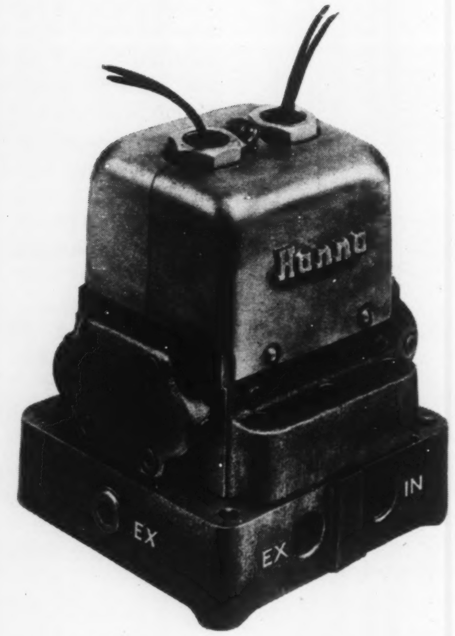


Fig. 1—Solenoids position an oscillating pilot valve to operate 4-way air valve

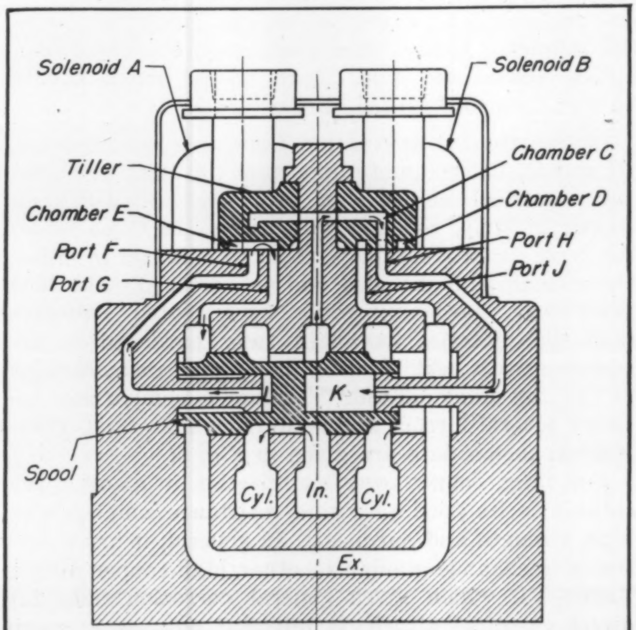
PILOT operation by means of an intermediate pneumatic circuit simplifies the electrical control circuits needed for the unusual solenoid air valve illustrated in *Fig.* 1. The solenoids function to control a small volume of air which serves to actuate the movement of a packless balanced spool. Locked in position by air pressure, this spool requires no holding current; therefore momentary contact limit switches or pushbuttons may be used, eliminating the need for holding contactors or relays where this type of operation is desired.

In *Fig.* 2 is shown the interior operation circuit. Air from the inlet port is connected to chamber *C* of the pilot oscillating member referred to as the "tiller", so constructed that it contains two 3-way valves functioning as a single 4-way. Energizing solenoid *A* causes the tiller to assume the position shown. Pressure is directed through port *H* to chamber *K* within the spool, moving and holding it to the left; air in chamber *L* being discharged to exhaust through port *F,* chamber *E* and port *G.* Chamber *C* is blocked at the left side of the tiller by means of valve porting. The spool in this position opens the main inlet port to the left cylinder port and the right cylinder port to exhaust.

Energizing solenoid *B* reverses the conditions above, directing pressure to chamber *L,* moving the spool to the right. Air in chamber *K* exhausts to atmosphere through port *H,* chamber *D* and port *J.* The main inlet port is then open to the right cylinder port with the left cylinder port open to exhaust.

As actually built, the valve is shown partially in cross section in *Fig.* 3. *Fig.* 4 is a detailed plan of the pilot unit and *Fig.* 5 is an enlargement of the tiller cross section. Pilot valve assemblies are identical for all valve sizes. The tiller, *Fig.* 3, oscillates about a post and contains the essential parts of the pilot valve. Cast from magnesium alloy, Flylite 8, the tiller is heat treated for maximum strength. This alloy was selected for its high strength-to-weight ratio. Since the tiller may be called upon to oscillate in excess of 500 cycles per minute, it is apparent that light weight is imperative to reduce inertia to a minimum. At the point of contact between the tiller and each solenoid pin which imparts motion to it is a disk or bumper pressed into a blind hole, one in each side of

Fig. 2—Interior circuit showing how spool valve controls porting. Tiller contains two 3-way valves



the tiller and in line with the solenoid pins. These disks absorb the impact of the pins when the solenoids are energized and therefore, considering the wear and fatigue to which they are subjected, must be made from a material offering resistance to these factors. Stainless steel 420 is used because of its corrosion resistance qualities in the hardened state (Rockwell C-52) and its ability to meet the conditions mentioned.

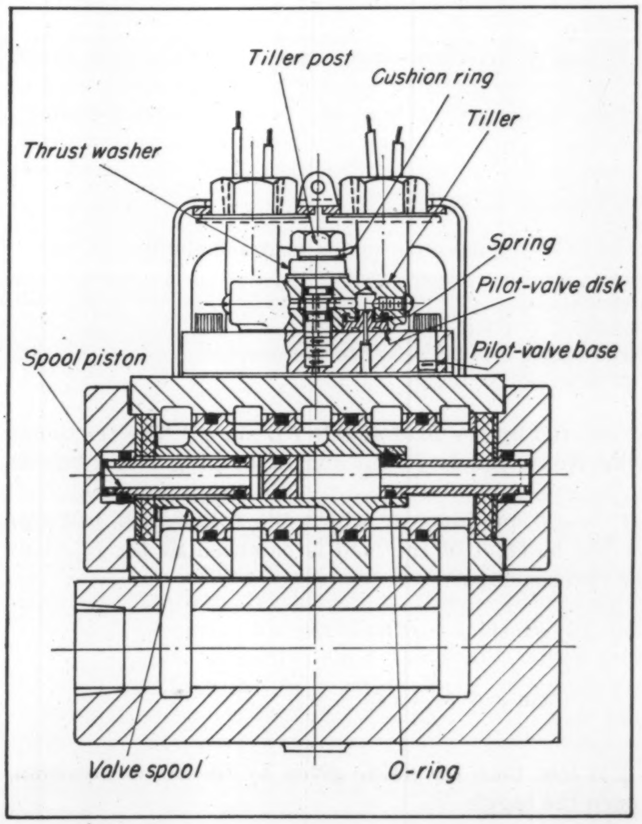
Within the lower side of the tiller at each end are the pilot valve disks *Figs.* 3 and 5. These disks are machined from phosphor bronze, ASTM Spec. 139-42T, and have a small hole through their center and an annular groove trepanned into the bottom concentric with the hole. This groove is represented as chambers *D* and *E* in *Fig.* 2. The bottom surface is honed to a microfinish.

Forms Airtight Seal

Top part of the disk has a neck extending upward into the recess of the tiller, and has bonded to it a feathered synthetic packing compound which is oil resistant and capable of extreme flexing. This permits the disk to form an airtight seat against the pilot valve base and allows for slight variation in alignment.

A spring is shown holding the disk against the base and provides initial compression only. When air pressure is admitted into the valve, the ratio of the area around the feathered packing at the top of the disk to that bearing against the base and tending to

Fig. 3—Section of valve showing details of tiller and valve spool. Plug in spool avoids making blind holes


Tiller post
Cushion ring
Tiller
Thrust washer
Spring
Pilot-valve disk
Pilot-valve base
Spool piston
Valve spool
O-ring

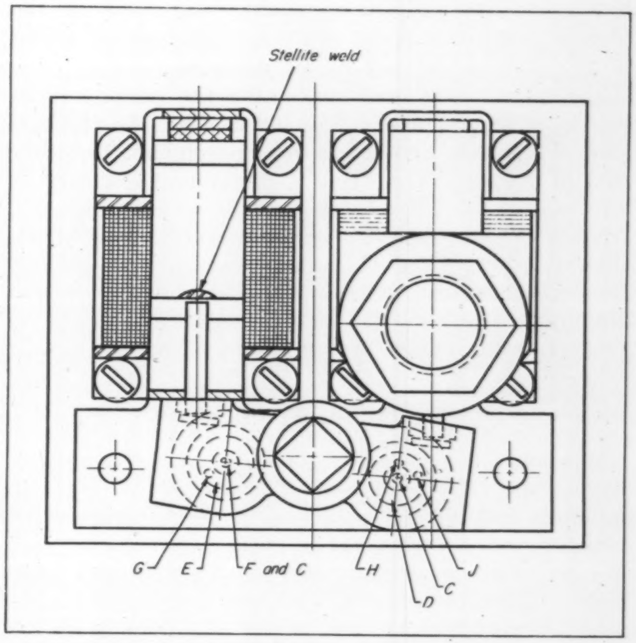
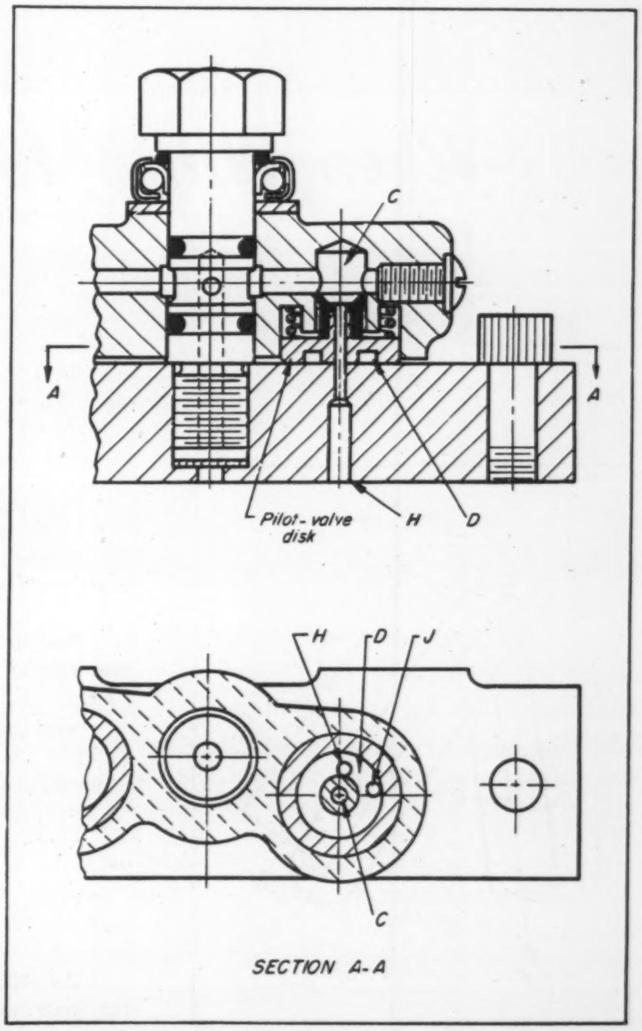

Stellite weld
G
E
F and C
H
C
D
J

Fig. 4—Above—Plan view of pilot unit

Fig. 5—Below—Cross section of tiller


C
A
A
Pilot-valve disk
H
D
H
D
J
C
SECTION A-A

blow the disk upward is slightly in favor of the former, with the result that a tight seal is maintained against the base by air pressure.

The pilot valve base containing the porting holes to the valve proper is a Niresist casting, the top surface of which is also honed to a microfinish. The tiller post is machined from type 416 stainless steel. At its top is a small ball thrust bearing which minimizes friction at this point due to the upward thrust of the tiller resulting from the unbalanced air pressure. A Neoprene cushion ring compensates for vertical misalignment and permits the bronze thrust washer to properly seat against the top of the tiller.

Prevents Mushrooming of Anvil

Solenoid pins are formed from nonmagnetic beryllium copper and hardened. The solenoids are sturdily built and at the points of contact between the plunger and outside armature are segments of Stellite weld which prevent mushrooming at the anvil point. Solenoid stroke is 5/32-inch and leather cushions absorb plunger impact on the return stroke. Split aluminum covers are splashproof and enable the solenoids to be removed individually if necessary. Where pin plug connectors are used, no wire breaks need be made.

Valve spool is machined from type 416 stainless steel. Outside diameters of the lands are first ground, then chromium plated, ground again and honed for a selective air-tight fit with the honed Niresist sleeve. The hole through the center of the spool in which rest the spool pistons is a through hole, with a sealed plug in the center, rather than a blind hole at each end, to permit a burnished finish to be applied to it by forcing a cemented carbide ball through its entire length, thus providing long life for the Neoprene friction-seal O-rings. The reamer size for this hole is 0.4985-inch and the ball diameter is 0.5000-inch resulting in a net interference of 0.0015-inch.

Other design features include the use of Neoprene O-rings between the sleeve and valve body. These rings serve both as cushioned spacers and seals between the air passages, with the result that distortion of any sort will not be transmitted to the carefully honed bore. Corrosion resistant materials are employed throughout the valve proper. Three-point mounting pads provide level mounting of the separate manifold base, the design of which permits straight line piping to either bottom or sides.

Several valves may be mounted side by side with minimum space requirements by eliminating the single manifold normally used with each valve and substituting a common panel or multiple manifold for as many units as may be needed. Such an arrangement may be employed to connect two or more valves to operate singly or, in the case of high air volume demand, the valves may be connected in parallel.

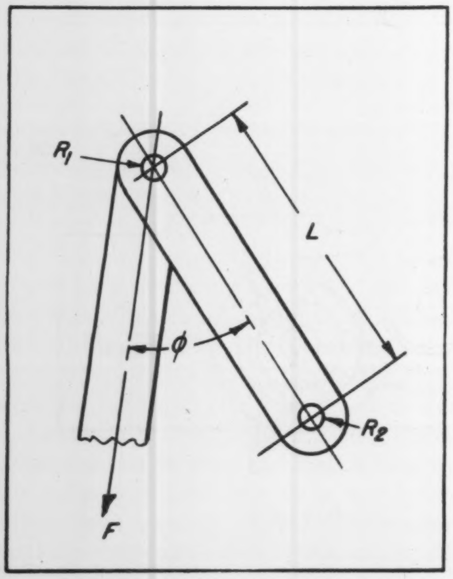
When Will a Toggle Snap Open?

By Macon Fry
Ordnance Consultant
Harrington Park, N. J.

IN DESIGNING toggles it sometimes becomes necessary to know how close to dead center position one can come and still have the load open the toggle. Such a problem was recently encountered by the author in connection with the design of a bomb release mechanism.

A typical toggle link is shown in the illustration. In the discussion, the following notation is used:

ϕ = Angle between the direction of the load and the line of centers of the toggle bearings
F = Force of the load
f = Coefficient of friction
L = Length of toggle link between bearing centers
R_1, R_2 = Radii of bearings on toggle.



The moment exerted by the load equals $FL \sin \phi$. The frictional moment at bearing No. 1 equals fFR_1, and at bearing No. 2 equals fFR_2.

The "critical" angle, or angle at which the toggle will just fail to open, is where the moment of the load is balanced by the frictional moments of the two bearings:

$$FL \sin \phi = fFR_1 + fFR_2$$

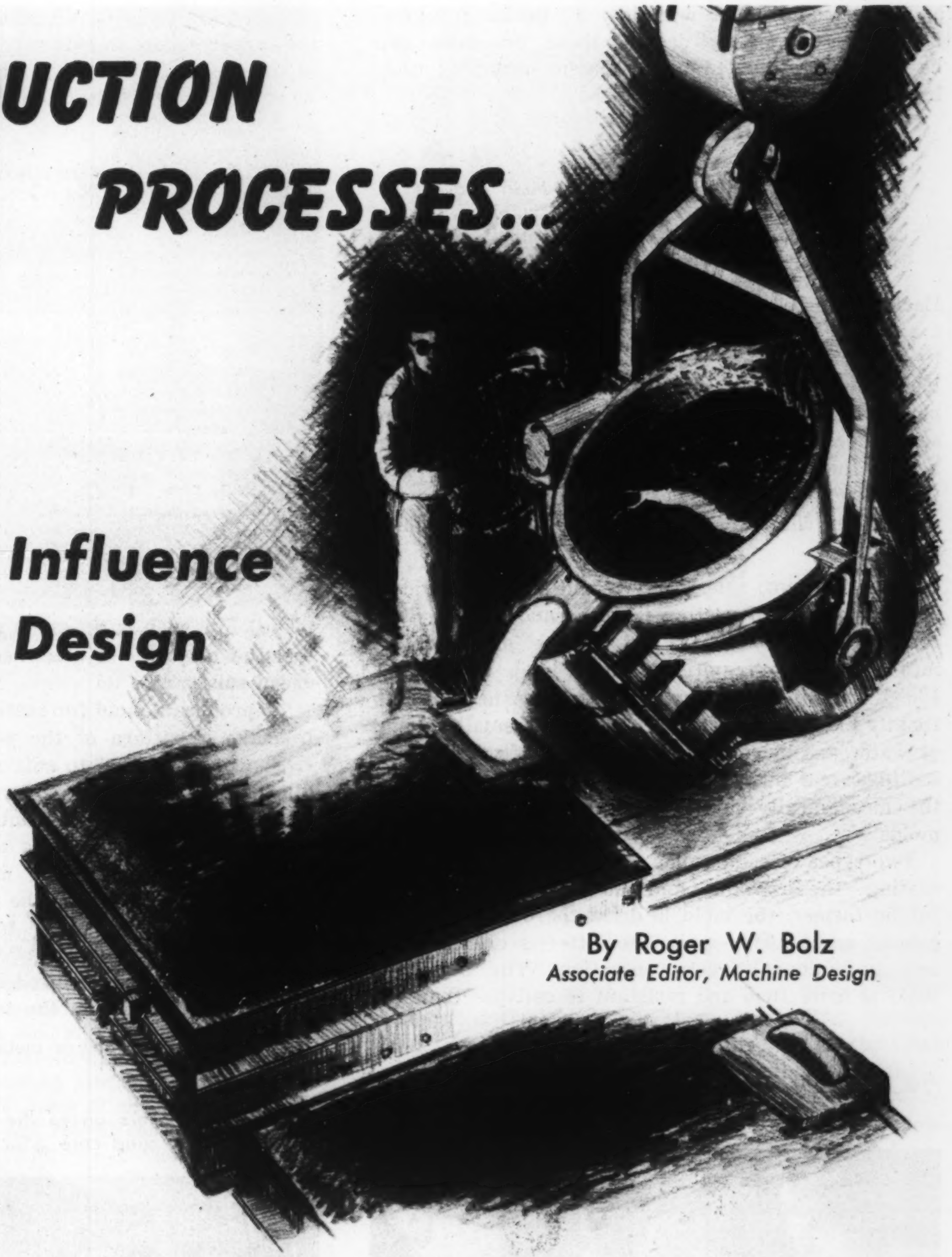
or:

$$\sin \phi = \frac{f}{L}(R_1 + R_2)$$

As long as ϕ is less than the value given by the above equation, the load cannot open the toggle.

PRODUCTION PROCESSES...

Their Influence On Design



By Roger W. Bolz

Associate Editor, Machine Design

Part XLV–Sand Casting

AMONG the multitude of processes utilized in the design of machines, those of casting perhaps receive the least attention and consideration. One of the earliest processes for forming metals, casting provides versatility and flexibility which have maintained its position as a primary production method for machine elements.

Any metal which can be melted and poured can be cast and the size range of parts regularly produced by these methods is greater than any other method producing similar results. Generally, casting methods can be divided into those using nonmetallic molds and those using metallic molds. To permit a logical breakdown regarding design, these processes can be further subdivided by the basic means of casting, as follows:

1. Sand Casting
2. Centrifugal Casting
3. Permanent and Semipermanent-Mold Casting
4. Die Casting (Hot and Cold Chamber)
5. Plaster-Mold Casting
6. Investment Casting

Each of these distinct methods will be covered in a separate article along with those factors pertinent to each. As is characteristic of other methods, castings can be produced which violate some or all of the basic principles of good design but such parts are seldom economical or commercially practical. It behooves the designer, therefore, to consider the practical aspects of casting design equally as well as the production character of any other of his machine parts.

SAND CASTING: Best known and still most widely applied method of casting is with sand molds. Sand casting consists basically of pouring molten metal into appropriate cavities formed in a sand mold, *Fig.* 1. The sand used may be natural, synthetic or artificially blended material. Along with a small amount of water and a bonding agent such as fire clay, bentonite, cereal binders or liquid binders for cohesion, the mechanically mixed sand is used to form the molds.

Two types of sand molds are generally employed in casting—the dry sand mold and the green sand mold. In the former, the mold is dried thoroughly prior to closing and pouring while the latter is used without any preliminary drying operation. The dry sand mold is more firm and resistant to collapse than one of green sand and consequently core pieces for molds are largely made in this way, *Fig.* 2. The resistance of dry sand molds to contraction prohibits their use where light or intricate castings of steel are to be made. For such parts green sand molds are essential and the majority of steel castings are now made in green sand.

Fig. 1—Pouring a group of small sand castings intended for heat resistant service

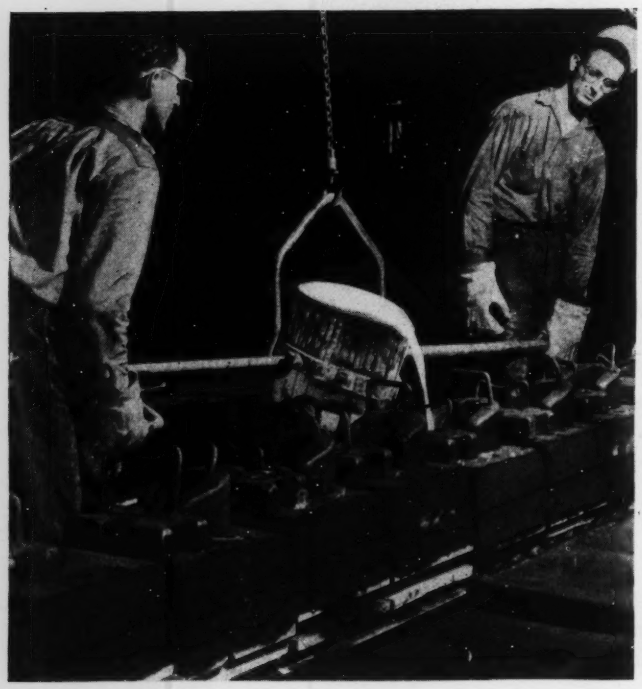


TABLE I—**Pattern Shrinkage Allowance**
(inches per foot)

Metal	Shrinkage*
Aluminum Alloys	1/10 to 5/32
Beryllium Copper	1/8
Copper Alloys	3/16 to 7/32
Everdur	3/16
Gray Irons	1/8
Hastelloy Alloys	1/4
Magnesium Alloys	1/10 to 7/32
Malleable Irons	1/16 to 3/16
Meehanite	1/10 to 5/32
Nickel and Nickel Alloys	1/4
Steel	1/8 to 1/4
White Irons	3/16 to 1/4

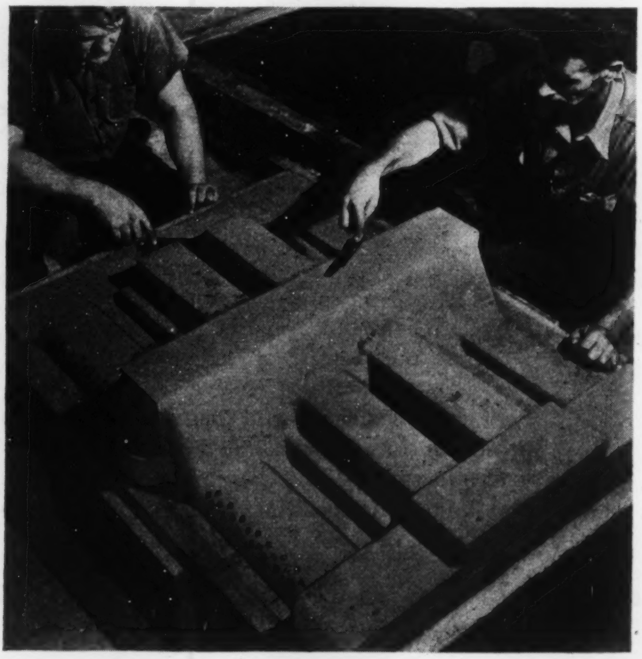
* Smaller value applies generally to large or cored castings of intricate design. Larger value applies to small, simple casting designs.

To produce a mold for casting a part it is necessary to make a pattern of the part. Patterns are made from wood or metal to suit a particular design with allowances to compensate for such factors as natural metal shrinkage and contraction characteristics. These and other effects as perhaps mold resistance, distortion, casting design, mold design, etc., which are not entirely within the range of accurate prediction make it necessary to adjust pattern dimensions to produce castings of the required dimensions.

Types of patterns utilized in sand casting generally can be classified as in the following:

1. Single, loose wood or metal patterns. Low in cost

Fig. 2—Coremakers giving the final touches to a large sand core prior to baking



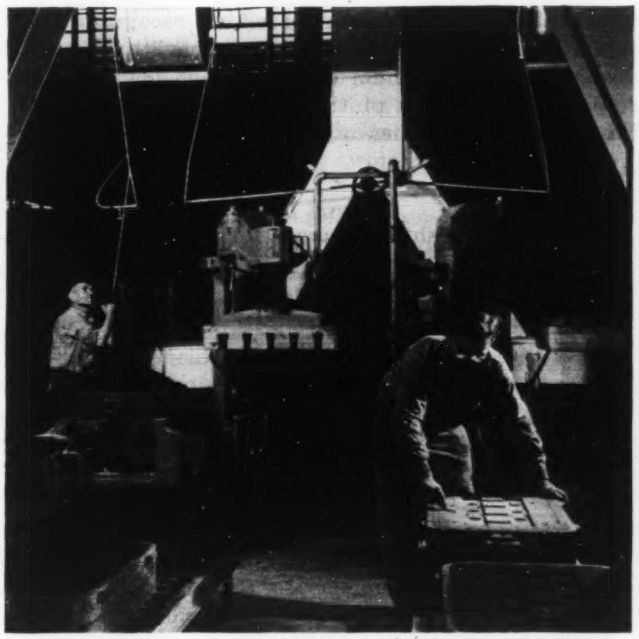


Fig. 3—Molders making the drag or bottom half of sand molds using separate metal patterns. The jolt squeezing machines shown are used largely for medium-size molds

but only satisfactory for very small quantities. Metal better than wood but subject to same limitations—gates and risers must be cut by the molder in each mold used

2. Gated wood or metal patterns. Satisfactory for small-run production. Wood subject to warpage and breakage
3. Metal match-plate patterns. For large quantities of small castings. Assure more accurate reproduction than loose patterns and increased cost is compensated by increase of at least 60 per cent in production over a similar gated metal pattern
4. Separate wood or metal cope and drag patterns. Permit good production on medium to large castings because the two parts of the molds can be produced simultaneously. Metal construction particularly suited for quantity production of medium to large size castings and to machine gang molding, *Fig.* 3.

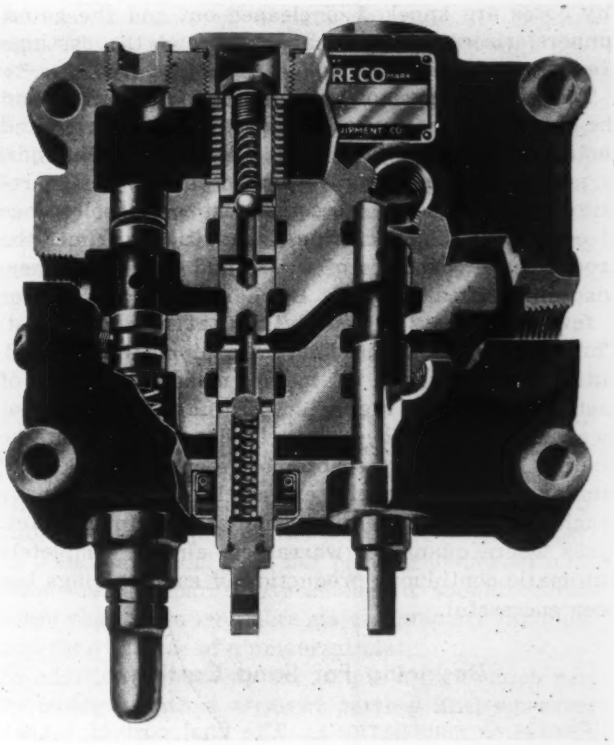
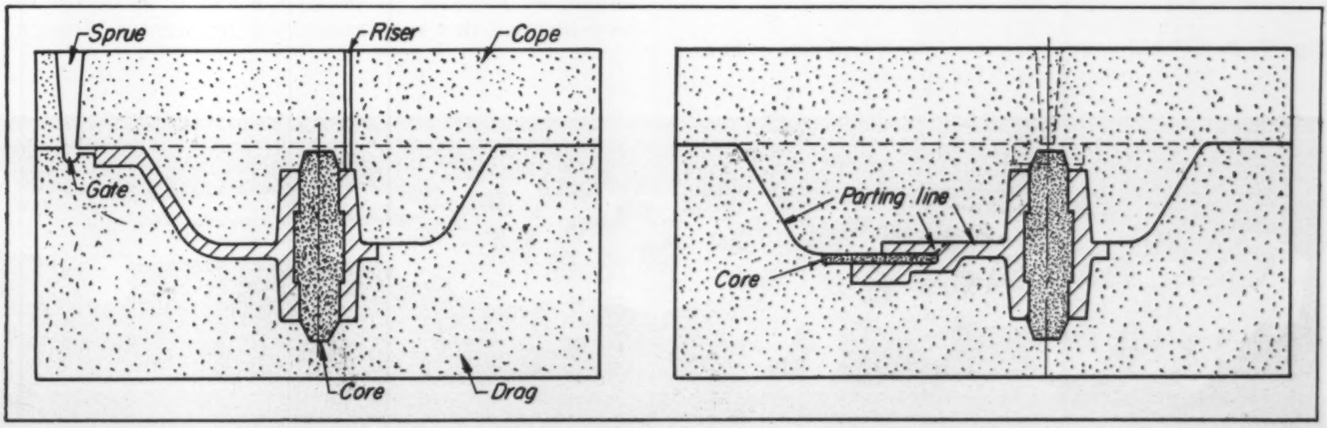


Fig. 4—Cutaway view of a hydraulic control valve. Complex coring work is necessary for forming the various interconnected fluid passageways with smooth flowing contours

In addition to the main pattern, most castings require cores, *Fig.* 4, to produce cavities or maintain desired contours or sections. In some cases, dry sand molds or cores are assembled to obtain an entire mold as with crankshafts and anchor chain. Thus, in addition to pattern equipment, core boxes are generally required to make the core pieces for a casting.

To produce a mold, the pattern is placed within a so-called flask which is then packed with molding sand. After the sand is thoroughly packed the flask is inverted and the pattern is withdrawn leaving a cavity of the desired shape and size, *Fig.* 3. When both top (cope) and bottom (drag) halves of a mold are completed in this way, any cores required are placed in position and the top flask is locked over the bottom, *Fig.* 5. Following pouring and solidification of the metal, the sand is shaken off the casting,

Fig. 5—Below—Cross section through a typical closed mold with a nonuniform parting line



any cores are knocked or cleaned out and the gates, runners, risers etc., are sawed off and the castings are ground smooth, *Fig.* 6.

The wide range of production possibilities and the expendable nature of the sand utilized gives sand casting outstanding flexibility. Patterns can be readily adjusted, changed or revamped to suit design requirements without excessive cost or obsolescence of equipment. Sand casting, in addition, permits the production of castings of a size and intricacy otherwise impractical, *Fig.* 7. By hand methods one or a few parts may be readily cast at minimum cost. Through the use of mechanized equipment for rapid, automatic production of molds, mass production of castings has been highly successful. The degree of mechanization has been largely dependent upon the quality. Items such as automotive engine blocks and similar parts, though extremely complex, have reached a high degree of mechanization. In some few cases where quantities warranted, almost completely automatic continuous production of sand castings has been successful.

Designing For Sand Casting

Design Considerations: The final cost of a casting involves far more than merely the cost of the metal. It is the ultimate cost of the machine part itself that is of most importance. Maximum economy in the final analysis may evolve from a casting design of greater rather than lesser weight, more machining rather than less, etc. Design which recognizes the inherent limitations present in casting will invariably help to assure maximum soundness and low scrap or rework. In selection of the material to be cast, the foundry characteristics of individual metals must be kept in mind. Each requires patterns which are made to suit and are not generally interchangeable. Craftsmanship and know-how can seldom substitute economically for inadequate design.

Table II
Machining Finish Allowances for Sand Castings*
(inches)

Metal	Casting Size	Finish Allowance
Cast Irons	Up to 12 in.	3/32
	13 to 24 in.	1/8
	25 to 42 in.	3/16
	43 to 60 in.	1/4
	61 to 80 in.	5/16
	81 to 120 in.	3/8
Cast Steels†	Up to 12 in.	1/8
	13 to 24 in.	3/16
	25 to 42 in.	5/16
	43 to 60 in.	3/8
	61 to 80 in.	7/16
	81 to 120 in.	1/2
Malleable Irons	Up to 8 in.	1/16
	9 to 12 in.	3/32
	13 to 24 in.	1/8
	25 to 36 in.	3/16
Nonferrous Metals	Up to 12 in.	1/16
	13 to 24 in.	1/8
	25 to 36 in.	5/32

* Courtesy American Foundrymen's Society.

† Allowance ranges up to 1 inch. Values are for ordinary finishes on the drag side of the mold where distortion is an unlikely factor. For surfaces to be cast in the cope allowances often must be doubled.

An ideal design, both from the standpoint of foundry practice and economy, should be possible to cast in green sand with a two-part mold. Where necessary, green sand cores should be usable and preferably the mold itself should provide for portions ordinarily cored. Size and awkwardness should be minimized to permit use of the smallest possible flask or where large machine parts are concerned, the smallest pit space. Ordinarily, gating and heading problems should be left to the foundry, but in all cases design should recognize the need for proper gating and heading positions on a casting, the need for free flow of metal to all parts of the mold, and the need for risers to feed the heavier sections continuously during solidification to compensate for shrinkage.

Patterns: Although the designer of a casting would seldom be involved in pattern work, it is useful to keep in mind this requirement of the process. Design

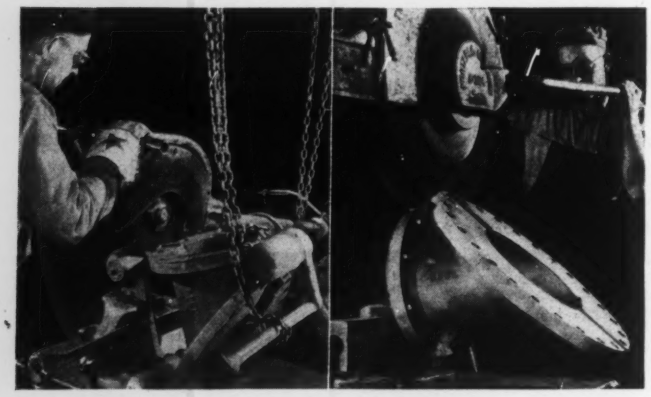


Fig. 6—Above—Sawing off the gates, runners, risers, sprues, etc., from a Hastelloy Alloy B valve casting. Blind risers and gating used can be readily seen

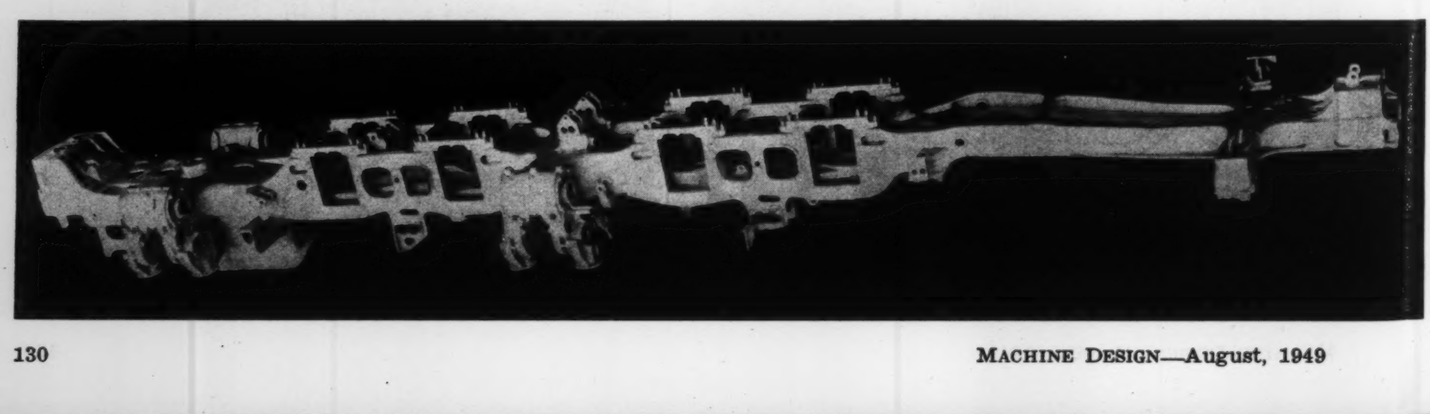


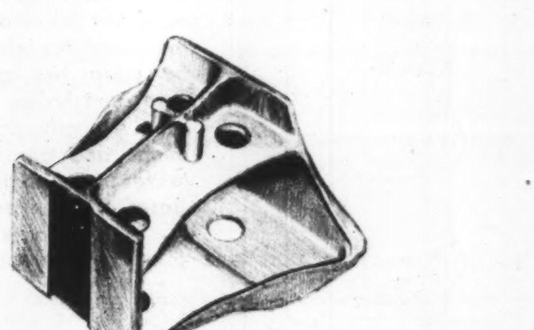
Fig. 7—Below—Gigantic one-piece steel locomotive bed casting for a T-1 size unit

should recognize the fact that although the removal of a casting from a sand mold brings in no withdrawal problems, the making of the sand mold by withdrawal of the pattern after ramming certainly does. Design to facilitate production of the sand molds will result in highly worthwhile economies, *Fig.* 8.

Contraction: Shrinkage allowances must be made on patterns to counteract the contraction in dimensions as the metal cools. The amount of shrinkage is dependent upon the design of the casting, type of metal used, solidification temperature, and mold resistance. All portions of a casting may not shrink uniformly as a result of these factors and being a volumetric contraction, it is difficult to predict accurately. Consequently, determination of the proper amount to use is a result of experience and should be discussed with the producing foundry. Shrinkage values normally employed are shown in TABLE I.

Draft: All surfaces perpendicular to the parting plane of the mold, i.e., in the direction in which the pattern or patterns are withdrawn, require draft to permit easy withdrawal. The usual amount for general-purpose work is ⅛-inch per foot or ½-degree per side. If the surface is not to be machined and the amount of slope does not interfere with its function, greater amounts of draft—one degree or more—may simplify molding and casting. With high-production molding equipment where pattern drawing is mechanized, less draft is necessary. Normally, in such cases 1/16-inch per foot is satisfactory.

Fig. 8—Casting design (a) is improved greatly by redesign as at (b) to simplify molding and casting



Interior features of a pattern ordinarily require greater draft than exterior portions. On high-production matchplate work about 2 degrees is necessary although in cases this can be reduced to 1 degree. Greater drafts are preferable if design permits. Unless the drawing specifies, draft may be divided by the patternmaker; subtracting half and adding half. However, it is usually preferable to add the draft material but not to incorporate in a drawing any dimensions which include the added thickness or length.

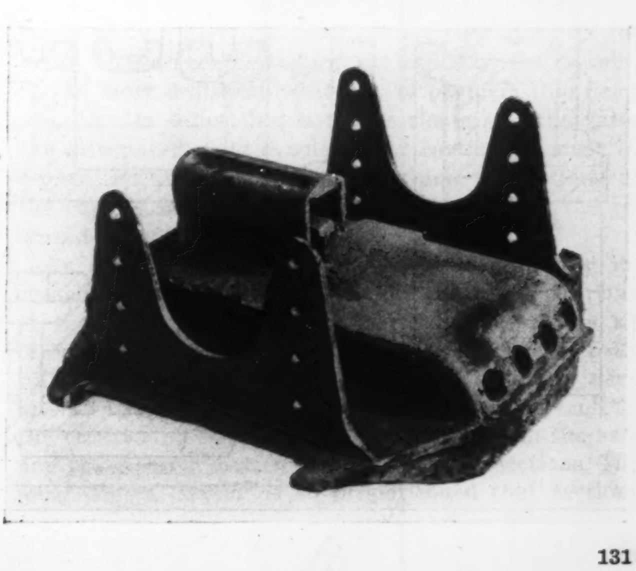
Straight Partings Most Economical

Parting Lines: Molds in general are most conveniently parted in a flat plane. Casting design, therefore, is most economical if the part can be molded with a flat rather than a curved parting plane, *Fig.* 5. Although high-production matchplate equipment permits some deviation from flat parting planes without serious mold preparation problems, it should be recognized that these irregular matchplates are far more costly than the use of a universal plate.

In addition to striving for simple design which permits molding with a straight parting line, wherever possible only a single parting in the mold should be required. The fewer partings in the mold, the less the work required to produce it. Pattern equipment is less complicated and the part can be more readily adapted to machine molding. Thus, three-part mold designs should be avoided by proper consideration during design.

Coring: All interior features of a cast design which are not possible to form in the mold with the pattern proper must be produced by means of coring, *Fig.* 9. Cores in general are costly to produce and set and wherever possible should be eliminated. Be-

Fig. 9—Floating draft sill center brace for a freight car. This steel casting which weighs approximately 425 pounds and measures 26 by 30 by 12 inches high, is a good example of a difficult coring and molding job requiring careful location of gates and risers. This casting was considered superior to numerous composite designs tried in an effort towards simplification



cause of the lower cost, green sand cores are preferable where cores cannot be eliminated. Because of the low strength of green sand cores, internal features produced with these cores cannot exceed their diameter in length or depth. Also, green sand cores require considerably greater draft than dry sand cores, which often can be made without any draft allowance.

Core Support Important

Where cores are necessary, it should be noted that they require adequate support in the mold. Core prints—sections added to the pattern to leave an imprint in the mold in which the corepiece can be placed—are required to provide this feature and the core extension which fits into the core print naturally will leave a hole in the casting wall. The vertical print surfaces should have at least 2 degrees of draft and may have as high as 15 degrees. In general, the length of print should equal its diameter or width. Prints must be so placed that the core weight is uniformly supported and so that any shifting, floating or sagging is prevented. Where prints are not practical, metal chaplets for core support can be and are used, *Fig.* 10, but it is usually preferable to avoid the necessity for their use by proper design, especially with pressure castings. Stub cores also should be avoided.

Core gases produced in casting are usually vented through the core prints as the simplest exit. Where a print is not available for such purposes one usually must be added. Besides the problem of venting core gases from a cored pocket there is the additional requirement that it must be possible to readily remove the core sand after solidification. Large core support prints not only facilitate setting and anchoring but also greatly simplify cleanout of the core sand, a feature which often becomes an acute foundry problem, *Fig.* 11.

Locating Surfaces: Stable checking surfaces should be indicated on any casting drawing to facilitate ready dimensional check of the part. Pattern shop, foundry, machine shop if required, and inspection departments should all be able to check a casting from

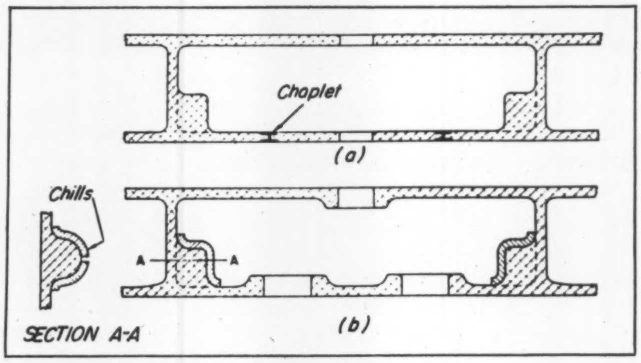


Fig. 10—Above — Cross section of a magnesium sand casting as originally designed at (a) which required chaplets for proper support of the sand core. Redesign at (b) eliminates the need for chaplets by using two spaced core print holes. Holes are srtengthened by beads and are larger to facilitate escape of gases and shakeout of chill pieces

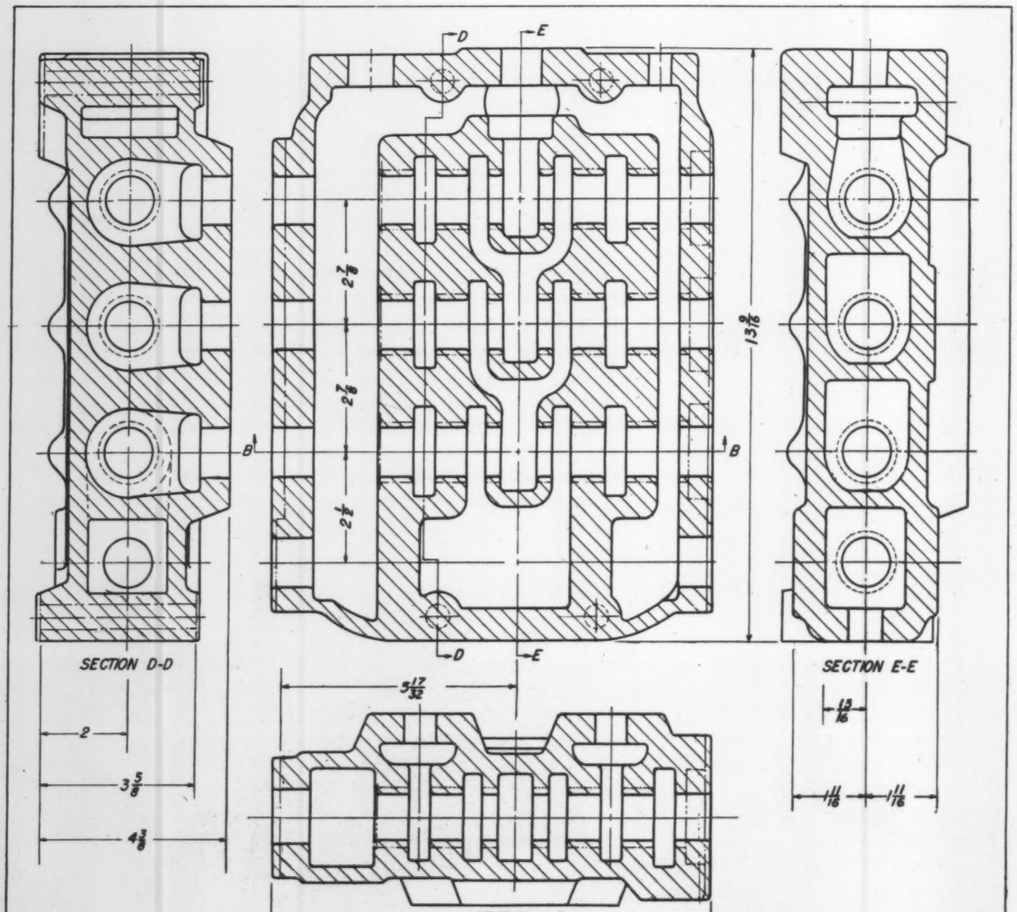


Fig. 11—Left — Drawing for a hydraulic valve casting. Complex coring such as this requires the ultimate in foundry skill. Complete removal of core sand from passages often presents a problem where hydraulic service is concerned

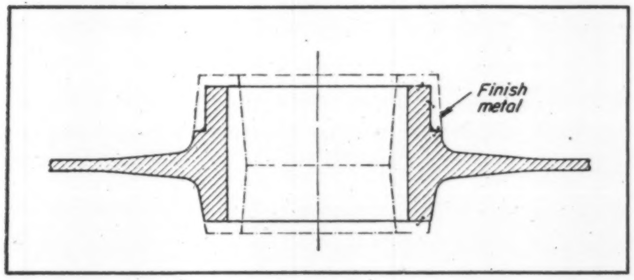


Fig. 12—Typical part showing the effect of machining allowances on the design of the casting

the same points. Wherever possible such surfaces should be located on the same side of the parting line away from the possible influence of shift of the cope, drag or a core. Several widely spaced surfaces which have no finish allowance and which are to be held to fairly close limits serve best for locational checking.

Checking and Machining Requirements

The requirements of locating, fixturizing and laying out for machining should also be kept in mind. If good locating points for checking are not available, it may prove that the part will be difficult to hold or lay out. In many cases special pads for locating, laying out or fixturizing a part should be added. The slight additional expense may prove to be a production economy.

Machining Allowances: Many castings can be put to use in the "as-cast" condition; that is, without any final machining or finishing other than the cleaning and sandblasting treatment usually employed. Where design is such that the normal tolerances obtainable in sand casting are satisfactory, maximum economy dictates use in the as-cast state. However, where more exacting dimensional accuracy is required, machining must normally be used.

To permit machining to flatness only, as with surface grinding, where some unmachined portions are satisfactory, a very minimum of additional metal need be allowed. If machining to a full flat or formed surface without imperfections is desirable, a greater amount of metal must be allowed. The allowance utilized for a particular casting depends upon the metal, the size and shape, the position of the particular surface in the mold, warpage or surface variations, machining method, and degree of surface perfection desired, *Fig.* 12. Nonferrous metals, such as brass, are less porous and have a thinner surface skin than ferrous metals and consequently permit the production of a fine finish with less metal removal. It is generally desirable to have surfaces which are to be machined, cast in the drag side of the mold. For those to be cast in the cope, extra allowance should be made because of unavoidable surface impurities which rise to the top during pouring. In TABLE II are given the usual finish allowances utilized with various materials and casting sizes.

TABLE III

Normal Minimum Sections for Sand Castings
(inches)

Metal	Section
Aluminum Alloys	3/16
Copper Alloys	3/32
Gray Irons	1/8
Magnesium Alloys	5/32
Malleable Irons	1/8
Steel	3/16
White Irons	1/8

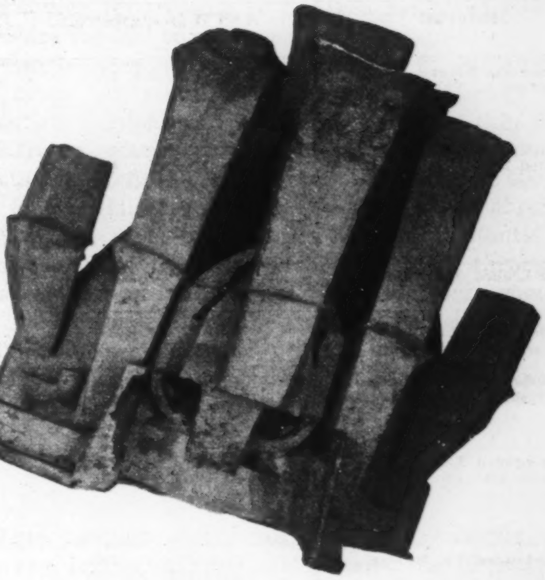


Fig. 13—A magnesium alloy nose section for a Wright Cyclone 18 engine after removal from sand mold. Sprues, gates, runners, and risers have not yet been removed. Heavy risers and chilling are necessary to assure sound metal in such a complex casting by equalizing cooling between heavy and thin sections

Section Uniformity: All cast metals require proper feeding of the molten metal into the mold to insure maximum soundness. As the molten metal solidifies, a contraction in volume takes place, requiring additional molten metal to continuously flow in to fill the voids. Risers on the casting are added by the foundry at the most desirable positions, to perform this duty, *Fig.* 13. In order that both the risers and the gates can adequately feed a solidifying casting, it must be recognized that the section sizes and proportions of the casting must be so designed as to permit the required flow of metal.

As a rule, the metal solidifies as a gradually increasing envelope or wall within the mold, starting at the mold surfaces and progressing inward in all directions. Because the thinnest sections generally solidify most rapidly, it can be seen that any very great variation in section thicknesses would result in the creation of severe contraction stresses in the soft and perhaps yet molten heavier adjacent sections. The ideal design should be so proportioned that sections

TABLE IV—Copper-Base Sand Casting Alloys*

Material	ASTM Designation	Tensile Strength (psi, as cast)	Elongation (% in 2″)	Applications
Leaded Tin Bronze (Steam or Valve Bronze)	B30-45T, No. 2A	38,000	35	Steam or valve bronze bodies; high-grade steam or valve metal for use at temperatures as high as 550 F; valve bodies subject to medium pressure; oil pumps; gears; bushings; high-duty bearings; backing for babbitt-lined bearings.
Leaded-Tin Bearing Bronze	B30-45T, No. 2B B143-46T, No. 2B	36,000	30	Wear-resistant high-duty bearings; strong, general-utility structural bronze for use under severe conditions; bolts; nuts; gears; high-pressure bearings and bushings to use against hardened steel; valves, expansion joints; pump pistons; electrical work; automobile bushings.
High-Leaded Tin Bronze	B30-45T, No. 3C B144-46T, No. 3C	30,000	15	Small bearings and bushings; bronze back for babbitt-lined automobile bearings.
High-Leaded Tin Bronze	B30-45T, No. 3B B144-46T, No. 3B	34,000	20	General-utility bearings, bushings, automobile fittings.
High-Leaded Tin Bronze (Bushing and Bearing Bronze)	B30-45T, No. 3A SAE 64	32,000	12	Bearings for high speed and heavy pressures; roll-neck bearings; lathe bearings; babbitt-lined armature bearings for electric locomotives; bearings in contact with mineral waters or papermill sulfite liquor.
High-Leaded Tin Bronze (Anti-Acid Bronze)	B30-45T, No. 3D B144-46T, No. 3D	30,000	15	Locomotive-engine castings and general-service bearings for moderate pressure; general-purpose wearing metal for rod bushings, shoes and wedges; freight and streetcar bearings; backs for lined journal bearings for locomotive tenders and passenger cars.
High-Leaded Tin Bronze	B30-45T, No. 3E B144-46T, No. 3E	21,000	10	Bearings under light loads and high speed, driving boxes, railroad bearings.
Red Brass (85-5-5-5) (Ounce Metal)	B30-45T, No. 4A B145-46T, No. 4A	34,000	25	General castings requiring fair strength, soundness and good machining properties. Low-pressure valves, pipe fittings, gasoline-line and oil-line fittings, small gears, fire equipment fittings, small pump castings, ornamental fixtures.
Leaded Red Brass (Hydraulic Bronze)	B30-45T, No. 4B B145-46T, No. 4B	32,000	24	General-purpose free-machining air, gas, and water fittings; plumbing supplies and fittings; pumps and pump bodies; hardware; carburetors; injectors; railroad catenary and overhead fittings.
Leaded Semi-Red Brass (Valve Metal)	B30-45T, No. 5A B145-46T, No. 5A	32,000	22	Low-pressure valves and fittings, general hardware fittings, plumbing fixtures, ornamental parts.
Leaded Semi-Red Brass (Plumbing Brass)	B30-45T, No. 5B B145-46T, No. 5B	32,000	30	Plumbing fixtures, cocks, faucets, stops, wastes, air and gas fittings, general hardware fittings, low-pressure valves and fittings.
Leaded Yellow Brass (High-Copper Yellow Brass)	B30-45T, No. 6A B146-46T, No. 6A	35,000	35	Yellow brass alloy plumbing fixtures, fittings and trimmings; valves; general hardware; ornamental work.
Leaded Yellow Brass (No. 1 Yellow Brass)	B30-45T, No. 6B B146-46T. No. 6B	34,000	35	General-purpose yellow castings; light castings not subject to high internal pressure; furniture hardware; ornamental castings; radiator fittings; ship trimmings; gas cocks and light fixtures.
Leaded Yellow Brass (Die-Cast Brass)	B30-45T, No. 6C B146-46T, No. 6C	40,000	25	Spring bushing alloy; hardware fittings; ornamental castings; ship trimmings.
High-Strength Yellow Brass (High-Strength Manganese Bronze)	B30-45T, No. 8C B147-46T, No. 8C	115,000	15	Extra heavy-duty, high-strength alloy for large valve stems, gears, cams; bearings (slow-speed, heavy-load type); screw-down nuts; hydraulic cylinder parts.
High-Strength Yellow Brass (Manganese Bronze)	B30-45T, No. 8A B147-46T, No. 8A	70,000	30	Propeller hubs, blades and other parts in contact with salt water and fresh water; gears; liners; valve stems; complicated lever arms where both strength and toughness are required.
Leaded Manganese Bronze	B30-45T, No. 7A B147-46T, No. 7A	65,000	18	Free-machining manganese bronze for valve stems, marine castings and fittings, pump bodies, gas-engine bases, lever arms, brackets, gears.
Nickel Silver (Leaded Nickel Bronze)	B30-45T, No. 11B B149-46T, No. 11B	50,000	15	Dairy and soda fountain equipment, valves and valve seats for elevated temperatures, hardware, keys.
Nickel Silver (Dairy Bronze)	B30-45T, No. 11A B149-46T	40,000	15	Marine castings, ship trimmings, furniture trim, hardware, valves, ornamental castings.
Nickel Silver (Benedict Metal)	B30-45T, No. 10A B149-46T, No. 10A	34,000	20	Hardware fittings, valves, valve trimmings, plumbing fixtures, ornamental castings, free-machining work.
Leaded Nickel Brass (Nickel Silver)		38,000	25	Free-machining brass for valves, hardware, boat and railroad-car fittings, pipe fittings.
Aluminum Bronze	B148-46T, Grade 9B B30-45T, 9B	62,000 to 90,000†	25 to 5	General-purpose aluminum bronze for pickling baskets, steel-mill slippers, nuts, internal gears, and marine equipment welding jaws. This alloy is subject to heat treatment.
Aluminum Bronze	B-148-46T, No. 9A B30-45T, No. 9A	75,000	35	Acid-resisting mine pumps (resistant to mild but not strong alkalies), valve seats, guides, stems, propellers, worm wheels, bearings, bushings.
Aluminum Bronze	B148-46T, No. 9C and 9C-HT B30-45T, No. 9C and 9C-HT	75,000 to 110,000†	18 to 5	Bearings, gears, worm gears, bushings; or any application where strength, ductility, and resistance to shrinkage are required.
Aluminum Bronze	B148-46T, No. 9D and 9D-HT B30-45T, No. 9D and 9D-HT	95,000 to 115,000†	7 to 5	Valve guides, valve seats in airplane engines, bearing plates under heavy loads, corrosion-resistant parts, gun mounts and slides.

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* Compiled from *Metals Handbook*, 1948 Edition, American Society for Metals.

† Tensile strength varies with percentage of aluminum and heat treatment. Elongation is reduced as tensile strength and hardness is increased.

farthest from the feed heads solidify first, with solidifying action progressing to the feed head and risers, which are the last to cool.

It can be seen that severe variations in wall thickness often can result in castings having heavy intermediate sections which cannot be fed. If thin sections freeze before heavy interior portions, shrinkage defects are likely to occur in these so-called hot spots. This is especially true in steel castings where shrinkage is most severe, Table I. Where substantially uniform section thickness is not practical throughout a casting, as is often the case, the design should take into consideration the problem of feeding and solidification sequence and provide adequate sections leading to the heavier portions or allow progressive increase in section toward the feeders.

Section Variation Limited

Where adequate risers can be applied, however, no arbitrary limits on reasonable variations in section thickness need be considered, *Fig.* 13. As a rule, sections remote from risers may vary plus or minus 20 per cent without recourse to special foundry technique. Somewhat greater variations can often be handled through the proper application of chills or other special handling. It has been found that ferrous chills of sufficient size will effect a solidification or freezing rate in steel approximately 2½ times that in sand only. Thus a heavy section away from a riser can be properly fed through a thinner section providing the section is not over 2½ times the thickness of the connecting section. Chills generally cannot be used in iron casting, but the foregoing rela-

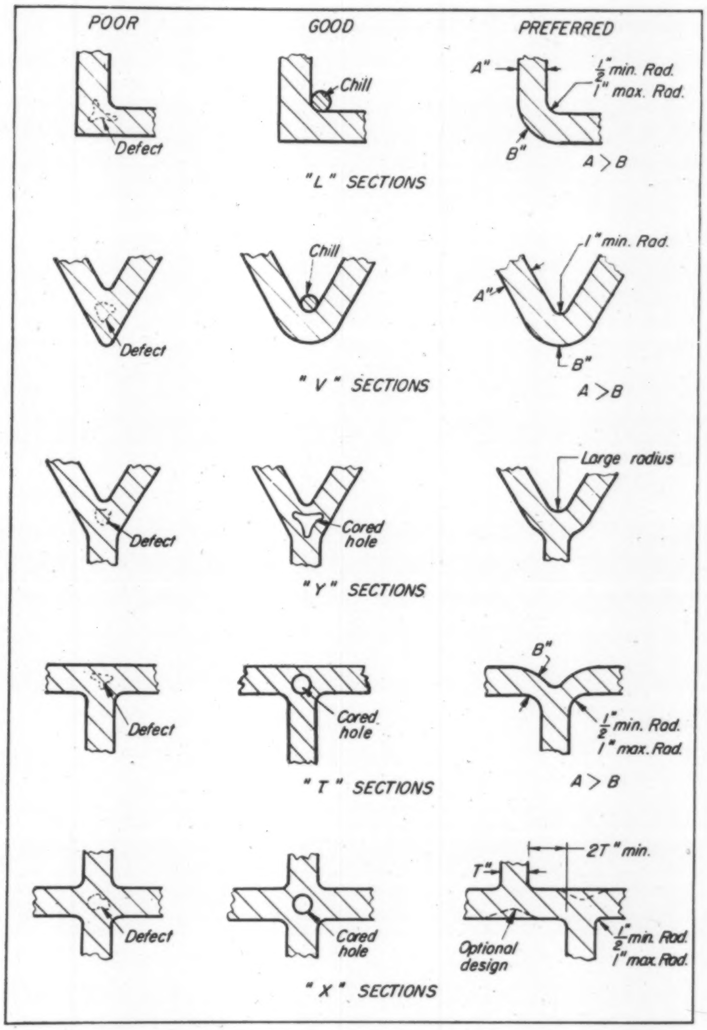

POOR
GOOD
PREFERRED
Defect
Chill
A"
1/2" min. Rad.
1" max. Rad.
B"
A > B
"L" SECTIONS
Chill
Defect
1" min. Rad.
A"
B"
A > B
"V" SECTIONS
Defect
Cored hole
Large radius
"Y" SECTIONS
Defect
Cored hole
B"
1/2" min. Rad.
1" max. Rad.
A > B
"T" SECTIONS
Defect
Cored hole
T"
2T" min.
Optional design
1/2" min. Rad.
1" max. Rad.
"X" SECTIONS

Fig. 14 — Above — Design of unfed junctions in steel castings are particularly important. Heavy sections where walls join are critical regarding adequate feeding to eliminate shrinkage voids

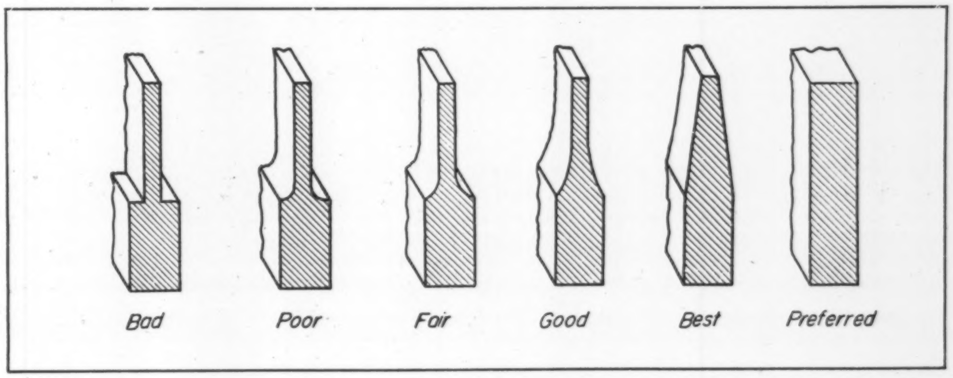

Bad
Poor
Fair
Good
Best
Preferred

Fig. 15—Right—Recommended design for blending of unequal sections to be joined

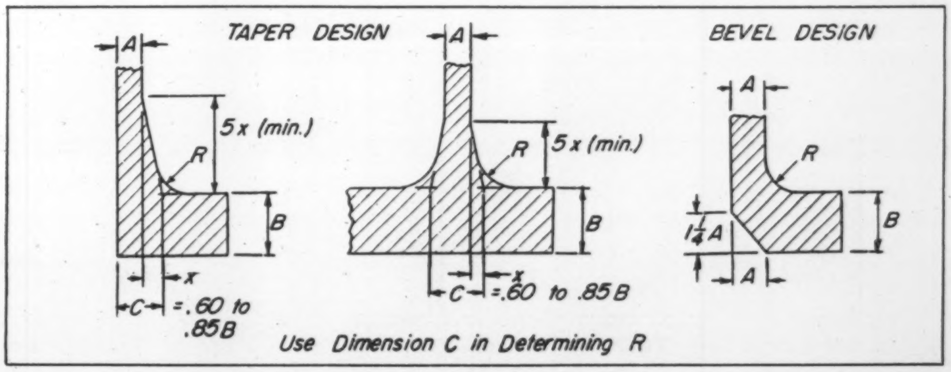
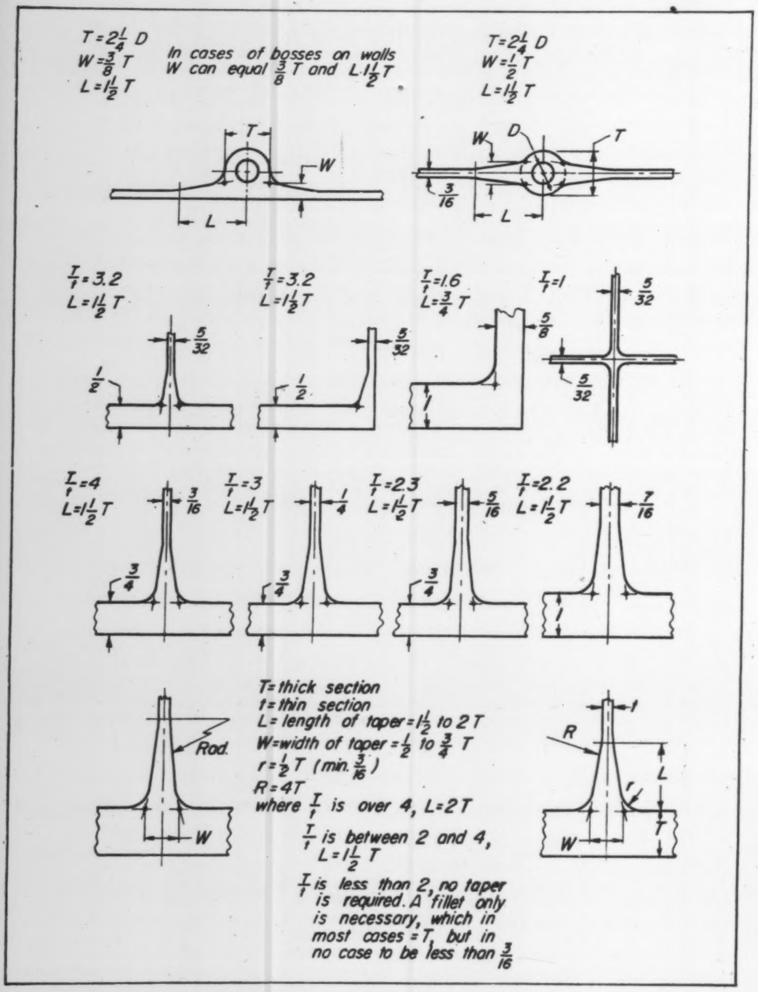

TAPER DESIGN
BEVEL DESIGN
A
5x (min.)
R
B
x
C
=.60 to .85B
A
R
5x (min.)
B
x
C
=.60 to .85B
A
R
B
1¼A
A
Use Dimension C in Determining R

Fig. 16—Right—Recommended design of junctions for malleable iron where one section is over 1.66 greater than the other. Variations in adjoining walls over 2.5 times are not advisable


$T = 2\frac{1}{4} D$
$W = \frac{3}{8} T$
$L = 1\frac{1}{2} T$
In cases of bosses on walls W can equal $\frac{3}{8}$ T and L $1\frac{1}{2}$ T
$T = 2\frac{1}{4} D$
$W = \frac{1}{2} T$
$L = 1\frac{1}{2} T$
T
W
L
D
$\frac{3}{16}$
$\frac{T}{t} = 3.2$ $L = 1\frac{1}{2} T$
$\frac{5}{32}$
$\frac{1}{2}$
$\frac{T}{t} = 3.2$ $L = 1\frac{1}{2} T$
$\frac{5}{32}$
$\frac{1}{2}$
$\frac{T}{t} = 1.6$ $L = \frac{3}{4} T$
$\frac{5}{8}$
1
$\frac{T}{t} = 1$
$\frac{5}{32}$
$\frac{5}{32}$
$\frac{T}{t} = 4$ $L = 1\frac{1}{2} T$
$\frac{3}{16}$
$\frac{3}{4}$
$\frac{T}{t} = 3$ $L = 1\frac{1}{2} T$
$\frac{1}{4}$
$\frac{3}{4}$
$\frac{T}{t} = 2.3$ $L = 1\frac{1}{2} T$
$\frac{5}{16}$
$\frac{3}{4}$
$\frac{T}{t} = 2.2$ $L = 1\frac{1}{2} T$
$\frac{7}{16}$
1
Rad.
W
R
t
L
r
W
T

T = thick section
t = thin section
L = length of taper = $1\frac{1}{2}$ to 2 T
W = width of taper = $\frac{1}{2}$ to $\frac{3}{4}$ T
r = $\frac{1}{2}$ T (min. $\frac{3}{16}$)
R = 4T
where $\frac{T}{t}$ is over 4, L = 2 T
$\frac{T}{t}$ is between 2 and 4, L = $1\frac{1}{2}$ T
$\frac{T}{t}$ is less than 2, no taper is required. A fillet only is necessary, which in most cases = T, but in no case to be less than $\frac{3}{16}$

Fig. 17—Above—Design recommendations for section junctions in magnesium alloy sand castings

tionships with most metals other than steel would not differ greatly.

Section Thickness: Wherever applicable, good practice dictates use of the minimum section thicknesses compatible with the design. However, the lightest wall which can be successfully cast depends upon the design intricacy, size and metal to be used. The normal minimum section recommended for various metals is shown in TABLE III. Section thickness must be proportioned to the area as well as to the adjoining sections as previously noted.

Pressuretight Steel Sections

Wall thicknesses down to $\frac{3}{16}$-inch can be poured in steel where size is relatively small and ¼-inch walls are cast regularly on small and medium-size parts. For highly stressed or pressuretight parts, however, wall thickness must be about double these values. With large castings, such as railway truck frames and bolsters, which are poured from steel specification AAR-M201, grades B and C, walls of $\frac{9}{16}$-inch and $\frac{7}{16}$-inch respectively, are required to assure free flow of metal in the mold. Sections up to as much as 4 feet thick have been cast in steel.

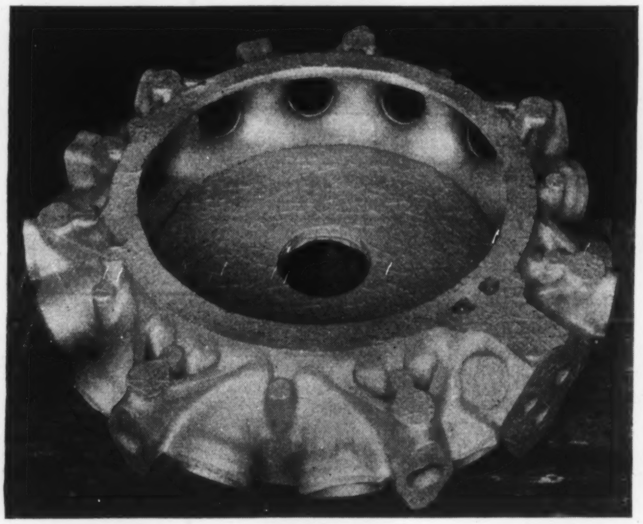


Fig. 18—Right—Magnesium alloy supercharger front housing for a Wright Cyclone 9 engine showing junction design, fillets and smooth flowing curves

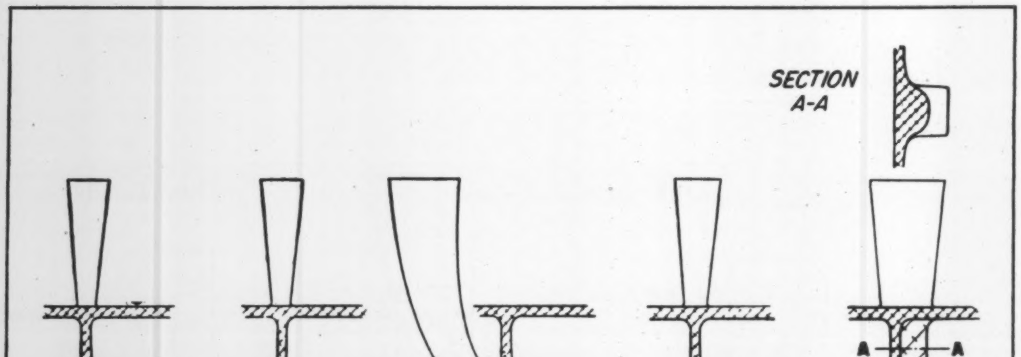

SECTION A-A
A
A
Chills
Chill
(a)
(b)
(c)
(d)
(e)

Fig. 19 — Left — Heavy round boss in a thin wall (a) is inaccessible to riser and will develop microshrinkage. Coring at (b) helps but is not always possible; horn risers (c) produce sound metal but are costly even if feasible; iron chills (d) reduce defects but design with channel as at (e) to feed boss is most efficient

Gray iron can generally be cast into sections as light as ⅛-inch and remain gray. High-tensile cast iron cast into sections under ¼-inch, however, may become hard and white at corners and edges.

Malleable iron can be cast in sections as thin as ⅛-inch and less in part sizes up to about 2 inches. Generally, however, sections from 3/16-inch to ¼-inch which are properly ribbed for strength have been found most practical. Sections of ½ to ¾-inch are most practical for castings of medium size. Large, flat areas will tend to sag in the mold and consequently 3/16-inch sections are restricted to areas up to approximately 8 by 8-inches. Larger areas require progressively greater thicknesses to suit. The maximum section practical in malleable runs up to about 4 inches.

With the nonferrous materials, section varies with the alloy, size, service pressure, etc. In brasses and bronzes the minimum section is generally set at 3/32-inch to avoid the excessive temperatures necessary to pour lighter walls. In aluminum sand casting alloys, 3/16-inch minimum wall is required for the majority of small and medium-size castings although walls as light as ⅛-inch can be poured where size is not excessive. The usual minimum wall thickness in magnesium alloys is 5/32-inch although under favorable conditions sections as light as ⅛-inch can be cast. Thin sections are extremely difficult to cast in large areas, especially if the area is in a horizontal position while pouring. Sections in excess of 2 inches can be cast in magnesium with good mechanical properties.

Section Junctions: Adjoining or connecting sections of a part are generally far more important and critical in a casting than the section proportions. Where features of a design come together to create a heavy section, a hot spot as previously mentioned is normally created. If proper feeding can be assured, only the solid contractional stresses need be considered. However, if away from the feeders the same problem as with section variation occurs—shrinkage voids within the larger and slower cooling area. Because steel is the most critical in this respect it can usually be assumed that a design satisfactory for steel in this respect will be generally satisfactory for other metals, *Fig.* 14.

Junctions Require Consideration

When member junctions cannot be fed directly, it is preferable to maintain substantially uniform walls throughout. For instance, groups of strengthening ribs should not converge into a single "X" intersection, *Fig.* 14. All ribs should be staggered or displaced so as to maintain a normal wall between junctions. Where very heavy section junctions are necessary, coring can sometimes be used to maintain uniformity, *Fig.* 14, although this practice increases the cost.

Where sections of differing thickness must be joined it is generally advantageous to blend in the lighter section by a gradual taper, *Fig.* 15. Recommendations for malleable iron junctions are shown in *Fig.* 16, and those for aluminum or magnesium alloys are shown in *Fig.* 17.

Corners and Fillets: Sharp corners exhibit considerable lag in cooling and are potential points of high stress with subsequent rupture being the frequent result. Adequate fillets at all section junctions are therefore a "must" for strength and soundness, *Fig.* 18. The fillet radius should generally be equal to the

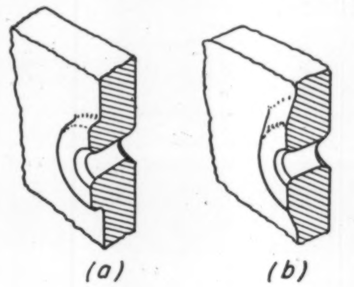


Fig. 20—Left—Bosses and pads which increase metal thickness should be blended into the casting wall as shown at (b) rather than as at (a) to improve metal flow

Fig. 21—Below—Magnesium sand casting showing a variety of bosses. Large boss top center and those in narrow web section are designed to be fed directly and those on top either side are carried on into the wall to permit withdrawal of the pattern

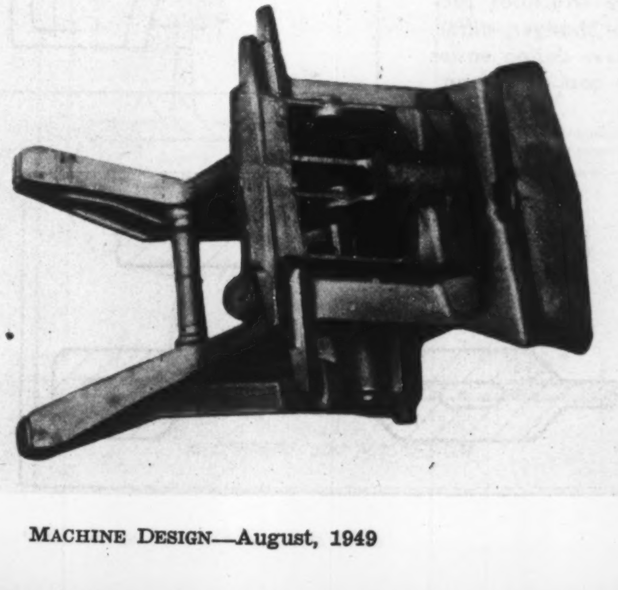
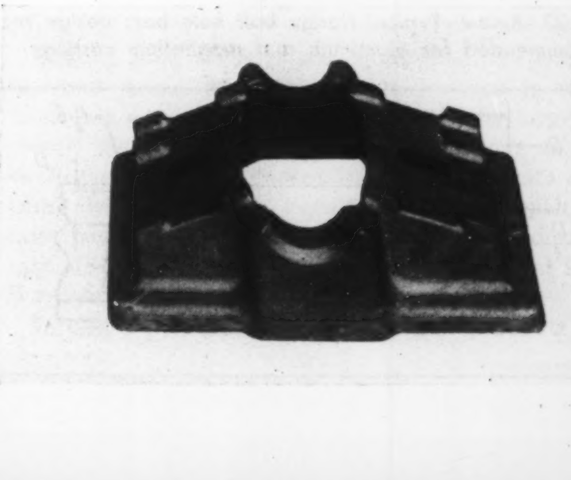


Fig. 22—Below—Magnesium sand casting showing raised pads on slanted surfaces properly designed for easy pattern withdrawal



section thickness and in joining unequal sections it should be based on the mean of the two walls. Seldom should the radius be greater than the section—too great a radius may develop a hot spot of metal. Suggested radii of fillets and corners for aluminum or magnesium alloys are shown in *Fig.* 17, and for steel in *Fig.* 14.

Isolated Bosses Require Feeding

Bosses and Lugs: Design features such as large bosses and lugs usually constitute heavy metal sections which demand adequate feeding for soundness, *Fig.* 19. In general, raised bosses or pads should be eliminated for ease in molding or should be blended into the surface to improve the casting, *Fig.* 20. Where bosses interfere with the removal of the pattern from the mold, metal should be added to permit withdrawal and eliminate the need for loose pattern pieces, *Fig.* 21. Primary consideration should be that the pattern can be readily withdrawn, *Fig.* 22. Where cores can be eliminated, design appearance and cost usually are improved.

Large, isolated bosses such as those used as hubs in gear blanks, wheels, pulleys, and other sections, cannot be poured where the connecting spokes or webs are slender. Uniform cross sections should be used in the spokes and rim with coring to reduce the internal hub section as well as the joint between the spokes and the rim. Spoke designs with an S-curve or a dished solid web on circular rimmed parts will allow the cooling stresses to be relieved without hot tearing.

In cases where bosses are in critical locations subject to severe operational stresses, as in the case of many aircraft engine castings, the use of typical boss design, *Fig.* 23, is undesirable. Actually, it has been found that in such cases raised bosses, *Fig.* 24, whether of round or odd shape, obviate all fatigue failure at the critical edge junctions of the machined surface.

Question of Rib Design

Ribs: Reinforcing and stiffening of cast parts in the past has largely been sought by means of added ribbing. Ribs also have been found to be useful in retaining flatness in large areas during the casting operation. It has been proved, however, that the actual design advantages of deep ribs may be somewhat questionable. As rib height increases beyond the section thickness to which the rib is attached, stresses at the rib junction increase rapidly to a point where the ribbed design actually becomes weaker under repeated stresses than the unribbed section, especially where the rib width to section width ratio is large. Large areas may therefore be somewhat strengthened by means of ribbing so long as rib height does not exceed about 1½ times the section thickness. Generous fillets at the rib junctions improve the design considerably. The rib design shown in *Fig.* 25 has been found to be a distinct improvement in the design of highly stressed structures such as aircraft engine components.

Conventional types of ribs should be governed by the rules regarding uniformity of section including the staggering of ribbing to avoid any possibility of massive junctions. Where such ribs are required by design they should be flat topped or beaded, rather than round topped, to reduce outer fiber stresses and minimize cracking, *Fig.* 26. The usual draft angle should be applied to ribs, especially for those in a vertical position in the mold and the base should be blended in as previously noted. Bead-top ribs are more efficient than plain ones but increase cost con-

Fig. 23—Below—Typical flange bolt hole boss design recommended for aluminum and magnesium castings

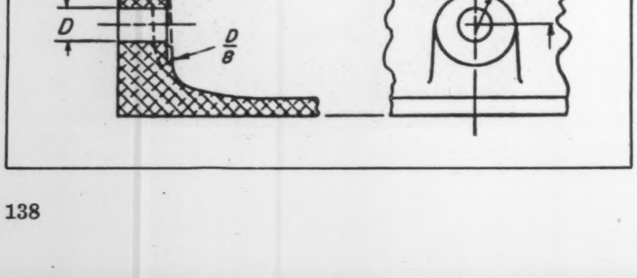


Fig. 24—Right — Design with raised bosses at points of high tension stress prevents fatigue failures which arise from machined spotface edge

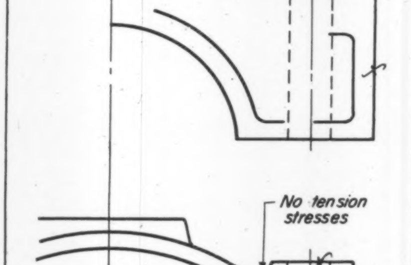
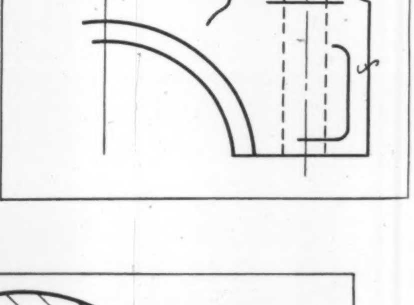
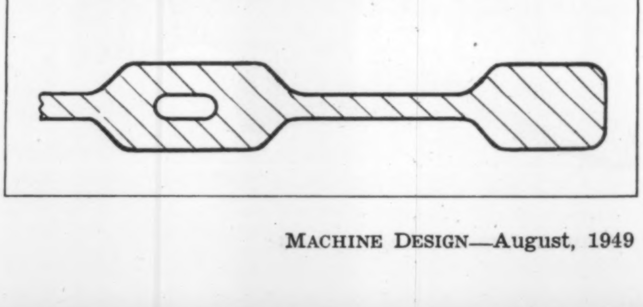


Fig. 25—Below—Low flowing wide ribs in aluminum and magnesium aircraft engine structures provide stronger, stiffer, lighter design easier to cast and clean





siderably owing to the coring necessary. Bead design for malleable iron is shown in *Fig.* 27. Generally, designing to place ribs in compression rather than tension is most satisfactory and helps eliminate fatigue cracking.

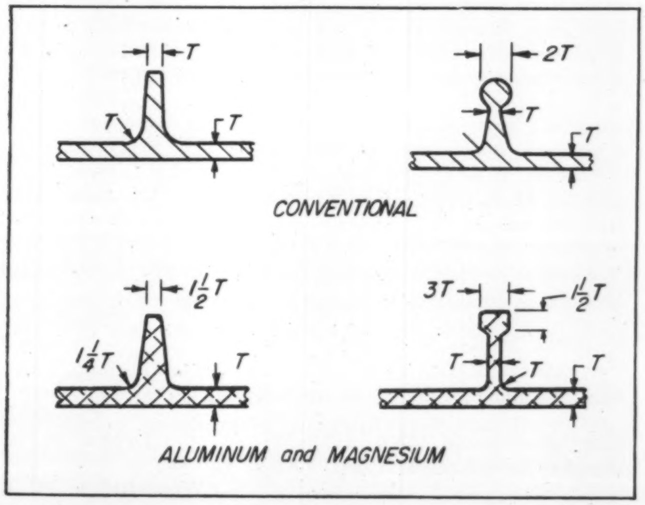
Beaded design is often desirable to secure stiffness at the edge of holes, particularly in light sections. Such beads, however, should not interfere with drawing of the pattern from the mold or cost may increase considerably. Beads at the parting line and those on the upper or lower mold surfaces are most easily handled. Bead design for aluminum and magnesium is shown in *Fig.* 28, and that for malleable in *Fig.* 27.

Cored Holes Have Multiple Uses

Holes: Small holes are normally not cored unless necessary for proper maintenance of wall section; in most materials drilling is the usual procedure but in malleable iron, holes which do not exceed the metal thickness can be cold punched if desired. Medium and large size holes are readily cored and may often be useful for internal core support or core sand cleanout. Core diameter for such holes should not be less than one-half the section thickness and, as a rule, the smallest cored hole which can be cast satisfactorily is approximately ¼-inch. Medium or large-size holes which require closer tolerances than are obtainable in coring must be bored or otherwise finished to size and require the addition of proper machining allowances. If sufficient draft is allowed and holes are equal to or preferably greater than the section, green sand cores can be used with maximum economy of production.

Pockets and Recesses: Deep pockets and recesses which complicate molding, prevent ready withdrawal from the mold, or require special coring should be eliminated unless such features are a distinct requirement. Undercut recesses should be avoided if at all possible and pockets should be of clean design with plenty of draft for easy drawing. Sharply projecting and overhanging features should be eliminated from cored sections inasmuch as they are easily broken off or washed out in pouring.

Fig. 26—Below—Conventional design for ribs to be sand cast and design for casting in aluminum or magnesium alloys. All edges or corners should be rounded



Inserts: Cast-in parts or inserts can be employed in the design of many castings. Such inserts require special foundry technique generally complicating the job of producing a sound casting and should never be utilized or called for unless no other design approach is possible. Only a mechanical bond is developed when metal is cast around an insert which may be cold or preheated to avoid shrink cracking during cooling. Consequently, to develop a good mechanical bond, special knurling, grooving or other keying features must be used on the insert piece.

Inserts of steel, cast iron or bronze are often used with magnesium castings to provide increased hardness, bearing strength or wear resistance at specific places. Steel or copper tubing can be used for ducts —oil passage in crankshafts for instance—and steel wires or ribbons can be used to obtain shapes not possible to cast. Pole pieces of laminated steel have also been cast into magnesium housings. Copper-base inserts for magnesium or aluminum usually require a chromium plated or sprayed iron finish to prevent undesirable alloying.

TABLE V

Typical Tolerances for Sand Castings

(inches per foot, plus or minus)

Metal	Tolerance*
Aluminum Alloys	1/32
Beryllium Copper	1/16
Cast Irons	3/64
Cast Steels	1/16
Copper Alloys	3/32
Magnesium Alloys	1/32
Malleable Irons	1/32

* Tolerance indicated generally for all dimensions, including wall thickness, core shift, etc. For dimensions under 12 inches, tolerance indicated is minimum.

MATERIALS: In general, almost any of the metals used in machine structures can be selected for use in a cast part on the basis of physical properties suited to the stresses and environmental conditions involved. It is necessary, however, to observe the major restrictions on size and wall thickness permissible.

Selecting a Cast Steel

Size of sand castings varies considerably with the material used. Steel castings may range in weight from but a few ounces to many tons, the largest on record being about 230 tons. Steel castings as much as 70 feet long and 10 feet wide with intricate structural design are cast regularly. For complete details concerning the selection of the most desirable cast steel, reference to the article "Which Cast Steel" is recommended*.

In cast irons, machine parts weighing from a fraction of an ounce to twenty tons or more are regularly produced. Likewise in malleable iron tiny parts weighing but a fraction of an ounce are cast and the major portion of castings range up to 25 pounds. Malleable castings, however, in the hundreds of pounds have been used.

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* E. J. Wellauer, MACHINE DESIGN, Feb. 1947.

Aluminum sand castings usually range from a few ounces to about 500 pounds although castings weighing as much as 7000 pounds have been made. Magnesium sand castings up to 10 feet in length with weight up to 1000 pounds have been produced with presently available equipment. The common copper-base sand casting alloys are shown in TABLE IV along with general data on their field of uses.

Malleable Can Be Cold Formed

The high machinability of malleable iron along with its freedom from casting strains and unique combination of high strength, ductility and shock resistance makes it an excellent material for many machine parts. Its freedom from the majority of casting design limitations regarding intricacy and section variation often permits the production of parts otherwise uneconomical to produce.

In designating cast materials the ASTM specifications or the minimum mechanical physical properties to which the casting must conform should be used rather than any chemical compositions. Due to differences in raw materials, foundry practices, etc., different manufacturers may use varying methods for obtaining the desired physicals. Thus with cast irons, if properties are critical, these must be specified in order to obtain the proper iron available from the wide variety of types produced. The term "cast iron" is nonspecific and therefore is only a general classification. Also, the terms "semisteel" and "high-test cast iron" are generally obsolete and should not be used.

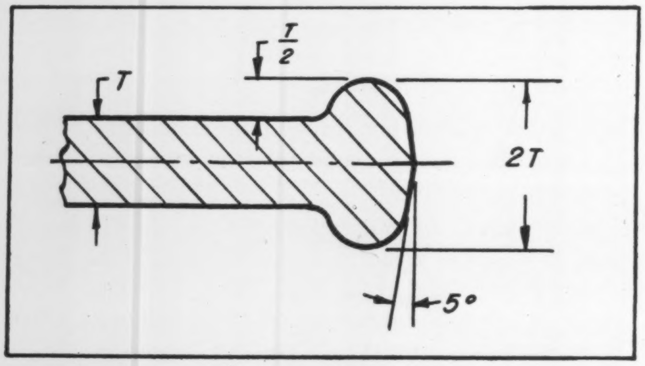

Fig. 27—Above—Typical section showing bead-edge design recommended for sand-cast malleable irons

TOLERANCES: In a single casting, the metal shrinkage ordinarily varies over the casting and in different sections anywhere from about $\frac{1}{32}$-inch to as much as $\frac{5}{8}$-inch from the dimensions which were provided for in the pattern. Exact reproducible tolerances for castings are for the most part a result of experience with many differing designs. Close tolerances, especially, cannot be accurately predicted and may require some trial runs with subsequent pattern adjustments to obtain suitable results.

Generally speaking, sand castings can be produced to tolerances which are approximately one-half the maximum shrinkage allowance for the metal being cast, TABLE I. Actually, the contraction of heavy castings of large size is less per foot than for small castings with light sections. Typical production tolerances applicable to sand castings produced in various materials are shown in TABLE V.

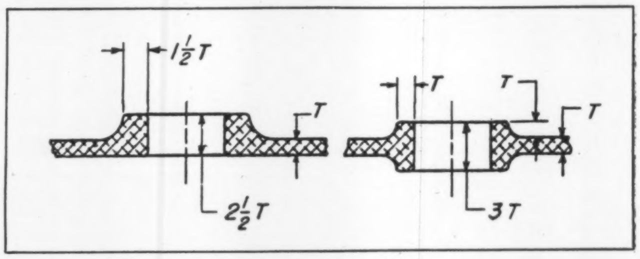

Fig. 28—Below—Bead design for stiffening holes in sand-cast aluminum or magnesium alloys

Surface finish on sand castings naturally is a result of the sand mix used in making the molds. The larger the part the greater the possibility for surface imperfections to creep in. The general run of sand castings range in surface roughness from about 250 to 1000 microinches, rms, and today some types of castings are being produced with surface roughness under 250 microinches with dimensional tolerances of plus or minus 0.005-inch per foot. These, however, are the result of special handling technique and such refinement of surface and dimension should not be demanded unless the expense involved warrants the special handling.

Collaboration of the following organizations in the preparation of this article is acknowledged with much appreciation:

Aluminum Association	New York
Aluminum Co. of America	Pittsburgh
Aluminum Industries Inc.	Cincinnati
American Brass Co.	Waterbury, Conn.
American Foundrymen's Society	Chicago, Ill.
American Magnesium Corp. (Figs. 10, 19, 23, 28)	Pittsburgh
Calumet Steel Castings Corp.	Hammond, Ind.
Eddystone Steel Castings Corp. (Fig. 7)	Eddystone, Pa.
American Brake Shoe Co. (Figs. 1, 2, 3)	New York
Haynes Stellite Co. (Fig. 6)	New York
Hills-McCanna Co. (Figs. 12, 17)	Chicago
Hydraulic Equipment Co. (Figs. 4, 11)	Cleveland
Malleable Founders' Society (Figs. 16, 27)	Cleveland
Meehanite Research Institute of America (Fig. 20)	Pittsburgh
National Malleable & Steel Castings Co.	Cleveland
Permanente Metals Corp. (Figs. 21, 22)	Oakland, Calif.
Steel Founders Society of America (Figs. 8, 14, 15)	Cleveland
Symington-Gould Corp. (Fig. 9)	Depew, N. Y.
Wright Aeronautical Corp. (Figs. 13, 18)	Wood-Ridge, N. J.

ENGINEERING INTERNS

By K. B. McEachron, Jr.
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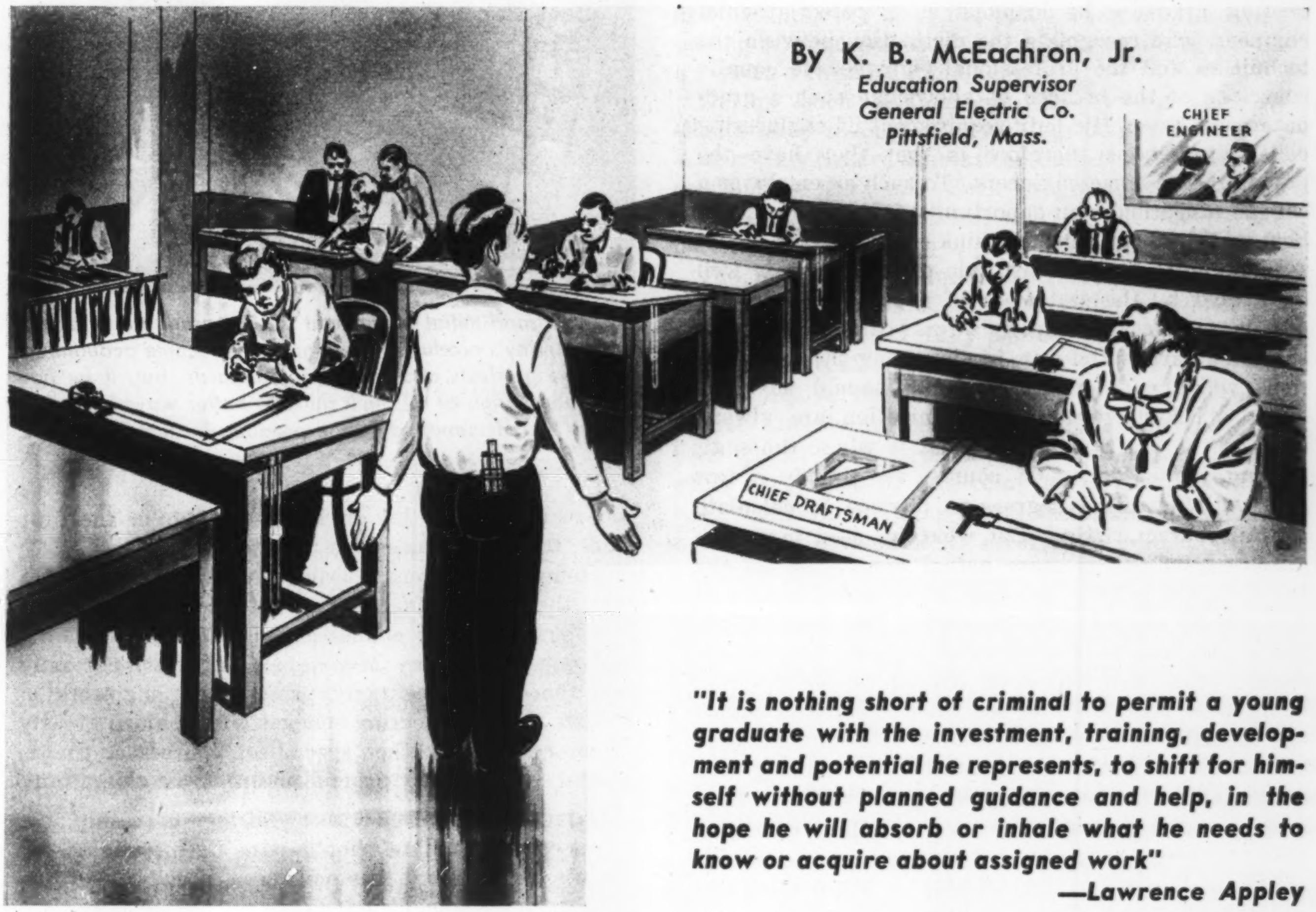

> ***"It is nothing short of criminal to permit a young graduate with the investment, training, development and potential he represents, to shift for himself without planned guidance and help, in the hope he will absorb or inhale what he needs to know or acquire about assigned work"***
>
> ***—Lawrence Appley***

FAR from being peculiar to engineering, that period which marks the transition from theory to practice is characteristic of all true professions. Law, medicine, the ministry, and teaching have all recognized the importance of this period by definitely establishing it, whether toward the close of formal training or following it, as a prerequisite to practice in the profession. Not only does this period provide needed experience but in most cases it serves to test whether the neophyte can achieve the necessary application of theory to practice. So accepted a part of training for the medical profession has such a period become, for example, that when the word "internship" is used, a very definite mental picture of the hospital intern in training for his profession is formed. Since this term is so familiar, it can be used to describe the similar period of training and experience which should follow graduation from an engineering school.

IMPORTANCE OF INTERNSHIP: Of all the professions, engineering is probably most difficult for the public to delineate from associated trades. This difficulty may arise from the nature of the materials with which the engineer works. Where other professions are concerned with relations among people and the physical well-being of people, engineering is primarily concerned with materials and products used by people to improve their standards of living. The idea that other professions must require a period of internship is readily accepted. A doctor, for example, could hardly be expected to learn how to perform a difficult operation by reading a text without some actual operating experience. On the other hand, an engineering graduate is often expected to be prepared to solve practical problems immediately without a period of gaining experience and adjusting theory to practice. To this extent industry has regarded the engineering graduate as an accomplished technician rather than as an engineer in training.

This mistaken practice has helped to destroy whatever professional consciousness the engineering graduate has developed in college and it delays and often prevents entirely his ever becoming a professional engineer. Colleges, too, are faced with a serious problem in the education of their men. The indus-

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From a paper presented at the AIEE winter meeting in New York.

trial organization which looks upon the engineering graduate merely as a technician naturally demands of the colleges men who can fill the immediate need, with little interest in the attributes which will later determine his success as a professional engineer. The employer, by contrast, who considers every engineering graduate he employs as a potential chief engineer, who recognizes the distinction between the technician and the professional employee, is equally conscious of the breadth of knowledge such a graduate must have. His only requirement of engineering college graduates therefore is that they have the potential to become engineers. To such an employer a college education is an opportunity for a man to learn how to think, not what to think.

This contrast in the attitude of employers is well illustrated by the statement of a personnel director of a large aircraft company a few years ago. During the early part of the war, in discussing the qualifications which engineering graduates should have, he stated, "Engineers in my organization are always used on the drafting board. That is where the engineering job is done. Of course, we employ a few men with advanced degrees in physics to calculate air-foil characteristics. But what we need in an engineering college is more actual experience on the board." The radical changes in air-foil design and increase in aircraft speeds toward the close of the war made obsolete conventional designs. Men whose design experience had been limited to the drafting board were completely at sea when it came to adapting themselves to the new problems. Sometime later this same industrial representative, recognizing this deficiency in his own company, proposed a curriculum in engineering physics as a solution remarking that the great need was for men who had a broad understanding of the fundamentals of engineering and could apply them to many different problems. He believed that engineering education had failed to develop men with such broad understanding. Most of those who heard his statement would agree that his proposed course in engineering physics was merely a good basic engineering curriculum and that the real difficulty lay in his assuming, in the first place, that an engineer is a technician.

". . . establish a close working relationship between the college graduate and experienced personnel"

". . . a good initial assignment for the graduate is testing the company's products. He'll not only become acquainted with the products and company standards, but, if he has any imagination at all, he'll think of better ways to design and manufacture the products he tests"

If employers of engineering personnel never forget that the engineering graduate is not *yet* an engineer but with wise counseling and adequate training and experience may *become* an engineer, not only will there be more truly professional engineers in industry but engineering colleges will be aided greatly in determining whether specialized courses or fundamental engineering principles are most important.

OBJECTIVE AND DURATION: During internship, the engineering graduate should gain that training and experience which it has not been possible for him to obtain in college and do so in such a way that at its completion he assumes the full responsibilities of a professional engineer. It is not a difficult task to provide some kind of industrial experience for the new technical enmployee. All too few companies, however, realize that the *type* of experience provided at this point will probably do more to shape the attitudes of the young engineer than any other experience he will ever have.

More important than any other single factor is the relationship between the graduate and the recognized engineer. Associations between master and apprentice, doctor and intern, and artist and novice have evolved naturally as the most effective way by which the necessary training and experience can be gained either for craft or profession. This method of training, while more effective than any other, has become less practical as industry has grown in size and specialization.

The company with a small, well-knit engineering staff has a unique opportunity to develop an intimate working relationship between its recent college graduates and its established engineers. Even the company with a single good engineer and a sincere interest in developing others can take full advantage of this most effective training method.

The larger the company, the more intensive the effort required to make effective this period of internship. From a comparison of activities of this type organized by various companies, the erroneous conclusion is often drawn that large companies are inherently suited to give the engineering graduate superior training and experience.

Time required to achieve full professional status following graduation from college will naturally vary among individuals. However, those men who have studied this problem carefully have in most cases limited the attainment of legal recognition as an engineer to those graduates who have completed from three to five years in the active practice of their profession.

THE PRIMARY EMPHASIS: Of what then should this period between graduation from college and entrance to the profession consist? Where the primary emphasis in college has been upon the study of engineering fundamentals, the emphasis in industry must be upon the application of these fundamentals to actual engineering problems.

Four Key Adjuncts to Engineering Internship

1. *The engineering graduate should be properly and carefully introduced to his company, his community and his professional society*
2. *Opportunities should be provided for the graduate to continue his technical education*
3. *Attention should be given to enlarging his areas of understanding*
4. *Adequate guidance and counseling should be available to him.*

The heart of this internship period must therefore be industrial experience. Since the new graduate is unfamiliar with industrial practice, his first job assignment must be of a relatively simple nature. In fact, it should be so simple that he will probably master it in a rather short time. He should then be given additional responsibilities or assigned to an entirely new job. Care must be taken to avoid the extremes of assigning a new man a job so complex he is completely bewildered or so simple that it presents no challenge to him whatever. By shifting him from one job to another at intervals of a few months, he will be successively stimulated in adjusting himself to new responsibilities and environments.

A type of assignment often used for such training is the testing of the company's products before shipment to customers. Such assignments are particularly desirable where the product is custom-made rather than mass-produced. The young engineer will then become quickly acquainted with the products the company manufactures and the standards which they must meet. If he has any imagination at all, he will also think of better ways to design and manufacture many of the products which he tests. In companies in which products are manufactured in quantity, a similar type of assignment in the group developing new products will be of like value whereas the routine testing of hundreds of identical units would be worthless from a training standpoint.

During such assignments, the young engineer should have an opportunity to advance from helping a more experienced man at the outset to complete responsibility later on. Such progress will give him a sense of accomplishment and provide for his superiors an opportunity to judge his performance.

The number of training assignments alone is no indication of the value of the training provided. A few assignments, carefully planned to give the young graduate actual work experience and as much responsibility as he can carry, will be much more effective than a number to which little thought has been given. The new employee can obtain worthwhile experience in any company, regardless of its size, where the training of its technical personnel is a first consideration of its supervisory staff.

AREAS OFTEN NEGLECTED: Actual experience on the job alone, however, will seldom be sufficient to transmute the engineering graduate into a professional engineer. The increasing size of the engineering profession makes more difficult direct contact between the newest engineering graduates and the leaders of the profession. The larger any group becomes the more it is subject to fragmentation and disintegration, and the engineering profession is no exception. On his first job the engineering graduate is particularly conscious of his lack of identity as a member of any group. He has lost the intimate contact with his college class with which he was so long associated and he is not yet established as a professional engineer. To meet this need during the period of internship and to equip the young graduate more adequately for his future responsibilities, industrial experience must be supplemented in four definite ways.

First: The engineering graduate should be proper-

". . . the newcomer should be made welcome"

ly and carefully introduced to his company, his community and his professional society. Although many employers will feel that their responsibility ends with acquainting the new man with the company, the attitude and performance of the engineering graduate is as much or more affected by his community and society experiences. In many cases, the community and the local section of his professional society will make independent arrangements to welcome him and to include him in their activities. But if the initiative is not taken by others, the employer must recognize the importance to himself of seeing that the new employee is well received in all three areas.

In larger organizations formal courses are usually planned to provide information about the company, its organization, and the opportunities for engineering graduates. Even though formal courses may be impracticable in smaller companies, a definite plan should be provided to meet this need. Asking engineers with a few years of experience to be personally responsible for making one or more new men "feel at home" when they first arrive has been the highly satisfactory answer of one company to this problem.

Second: An opportunity should be provided for the graduate to continue his technical education. So many companies have established training programs to meet this need that it hardly seems necessary to emphasize its importance. The large number of courses indicates, of itself, the value that industry places upon continuing the technical education of its engineering personnel. In the few years which a man spends in college, he cannot hope to obtain all the technical knowledge which he must have to discharge his engineering responsibilities successfully. Furthermore, if the engineering college has properly concentrated upon the fundamental principles of engineering, the graduate will need a considerable amount of technical training in specialized fields of particular interest to his company.

Problem Solvers not Project Solvers

Most industries will also recognize that the course method of instruction which is used in most engineering colleges tends to produce "pro*blem* solvers" rather than "pro*ject* solvers". Dr. R. E. Doherty has described his own experience in these words: "When I graduated, I had a burning desire to become a good engineer. But although I had passed creditably my work at college, I was still in a haze about much of the scientific and other theory I was supposed to have mastered. I found that I was not alone. Most of my associates, who came from colleges throughout the country, were in about the same fix. . . . The simple fact is, I had not learned how to analyze a situation in terms of general principles. Rather, I was looking for a formula and there was no formula; a general principle or concept was all that could help me." Industry must therefore expect to organize some courses designed to integrate the knowledge of the particular fields which the engineering graduate brings with him from college.

It would appear that the larger organizations have a definite advantage in the extent to which technical programs can be efficiently organized. This advantage, however, is more imagined than real. Many colleges are well equipped to provide extension courses in almost any specialized field and will welcome the active interest and participation of engineers in industry. The smaller company can more easily include the engineering graduate in technical conferences and discussions of products and operating problems. The important thing is that the company, large or small, recognize a need for the further training of its technical employees and make arrangements which are most effective and efficient. No successful business fails to organize the distribution of its products, whether large or small, in accordance with its needs. Too seldom, however, is the same attention given to the prospective engineers-in-training in industry.

Third: Attention should be given to enlarging the areas of understanding. Many technical graduates have a tendency to exaggerate the importance of purely technical ability. This tendency is a natural one, for most of these graduates selected engineering as a career because of their interest in mathematical and scientific fields rather than in business or cultural areas. While making use of the high degree of technical ability of the new graduate, industry should encourage him to broaden himself during the early years of his industrial experience. Only with a broad understanding of engineering and its relation to society can he develop professional stature. The forward-looking industry is therefore particularly anxious to provide an educational program in nontechnical fields such as economics, public speaking, and industrial relations. The employment records of many companies indicate that only a very small percentage of college graduates are released for lack of technical ability. In the past few years, engineering colleges have included many nontechnical courses in their undergraduate curricula to help meet this situation. The colleges alone, however, cannot be expected to provide a complete solution. Industry must recognize

". . . training in nontechnical fields helps to broaden the engineer—for example, public speaking"

that potentially it can provide much more realistic experience than educational institutions even in these areas. What it means to cooperate with the draftsman, the shop foreman, and the sales engineer in the design of a product, for example, can be demonstrated by actual case histories; or, in a different field, the effect of high inventories upon net profit is more readily appreciated when applied to an actual "going" business. Each company is, in a sense, a laboratory in which the results of applying simple principles of economics or industrial relations can be observed just as effectively as the physical test of a piece of equipment.

Fourth: Adequate guidance and counseling should be available to such employees. Without such guidance no amount of technical training or orientation programs will adequately discharge the responsibility of industry to the engineering graduate. Such guidance is most valuable when it comes from established engineers who have themselves faced similar problems. In a few short years, the engineering achievements of industry will be dependent on the resourcefulness and creative ability of these young men. During the period when they are forming their ideas of industry and their relationships to their company, community, and professional society, interest in them will do much toward inspiring them to improve upon work being done. Whether in industry or in education, there is a great tendency today to establish training programs or courses without attempting to measure their real value or to provide adequate guidance to those for whom they are designed. Years ago industrial organizations were small enough so that guidance and counseling were automatically provided in the day-to-day relations between established engineers and recent graduates. Today, however, this relationship is not sufficient to meet the needs of engineering graduates. Actually, many employers have so little real contact with their recent engineering graduates, other than on a purely business basis, that they have only the vaguest ideas of their motivating attitudes. A successful guidance and counseling program will not only be of value to the new technical employees individually but also will help to measure the effectiveness of the period of internship.

". . . he must learn to cooperate with other employees"

OUR RESPONSIBILITY: Planning a period of internship for the engineering graduate is not a task to be taken lightly. The graduate enters this period with a strong ambition to become a great engineer. He is full of hope for the future and confident of his ability to succeed. In almost every case, he has all of the raw material necessary to achieve that success. That so many fail to do so, can largely be ascribed to the planning and guidance which industry often fails to provide, or at best, does meagerly and with half-hearted interest. What industry does with the engineering graduate at this time will determine whether the potential he represents will be realized in his development as a professional engineer, or whether, after years of training and investment, he will fail to measure up.

It is upon individual members of the engineering profession that this responsibility must weigh most heavily. A strong and vigorous profession, increasingly aware of its obligations to the public, is the reward for adequately discharging this responsibility. Further fragmentation and gradual dissolution of the engineering profession may well be the result if this challenge goes unanswered.

Washer Parts Are Glass Laminates

PILOT plant production of molded glass parts for automatic washing machines, has been started by Apex Electrical Manufacturing Co., Cleveland. The production method developed makes it possible to mold a Fibreglas-reinforced laminate into the intricate shapes required by a relatively simple process. The laminate has the strength and durability of many metals, but unlike metals it is impervious to most chemicals and is flexible enough to retain its shape.

At present, four different Fibreglas-reinforced laminate parts are being molded. They are water balance rings 22 inches in diameter and 12 inches deep, suds guards, clothes guards and water deflectors. The most intricate of these is the water balance ring which is an assembly comprising 41 parts. It serves as a water retaining compartment which compensates for out-of-balance of clothes in the centrifugal extraction of water during the drying cycle.

The Fibreglas material is supplied to Apex in strands containing 200 flexible glass filaments or fibers, each 0.0003-inch in diameter and 2 inches long. The glass fibers are mechanically separated and blown onto a "preform" screen. As the fibers are distributed evenly over the screen and held thereon by vacuum, a liquid binder is sprayed over them. Then the preform itself is removed from the screen and baked at 300 F. After baking, the preform is put into a heated steel mold and the thermo-setting resin is added. While in the mold, the form is subjected to a pressure of 45 tons for several minutes, and is ready for assembly when removed.

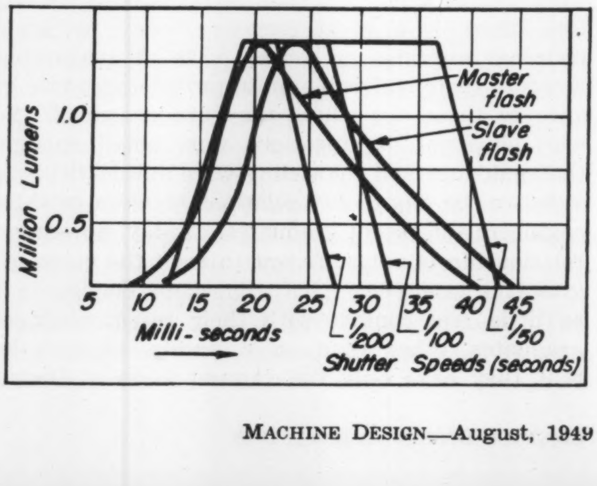
Contemporary Design

Light Impulse Triggers Flash Lamp

TRIGGERED by light from the flash lamp on a camera, the unit shown in the illustration, left, below, is a self-contained, battery-powered device that provides synchronized supplementary lighting for photography at shutter speeds to 1/200-second. Sensitivity is such that an increase of 6 foot-candles in the light level in rooms having general levels of ten to 200 foot-candles is sufficient to fire the unit. Capable of functioning from a distance of 500 feet, the remotely controlled lamp will also operate from the light of a flash lamp reflected from the walls of a room. In operation, closing an on-off switch charges a condenser and voltage is applied to the photo and trigger tube. Current produced by light falling on the photo tube is applied to the starter anode of the trigger tube, ionizing the gas and allowing the condenser to discharge across the tube through the flash lamp.

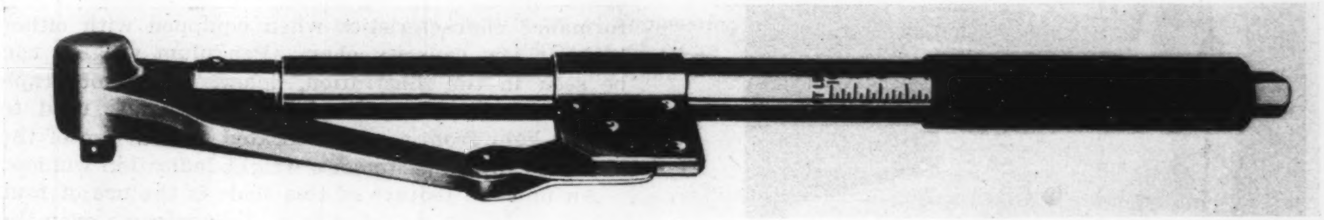
SERVO-FLASH

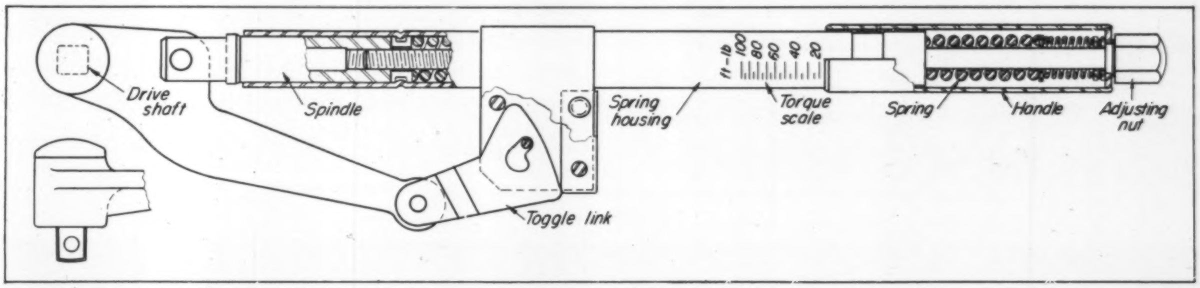
Synchronization between "master" and "slave" flashes is close enough to permit use of shutter speeds of 1/200-second and slower, as shown in the drawing below. Since there is a delay of about eight milliseconds in a synchro-press No. 5 lamp after current is applied before light from the foil is emitted, and since the slave unit fires at six foot-candles more than the prevailing light level, ignition of the primer material in the master lamp will trigger the unit when within a reasonable distance. The circuit is powered by two *B* batteries rated at 67½ volts connected in series, battery life being almost equal to their normal shelf life because of the small average current of 0.0009-ampere. Manufacturer: Era Tool and Engineering Co., Franklin Park, Ill.



Torque Wrench Employs Toggle Principle

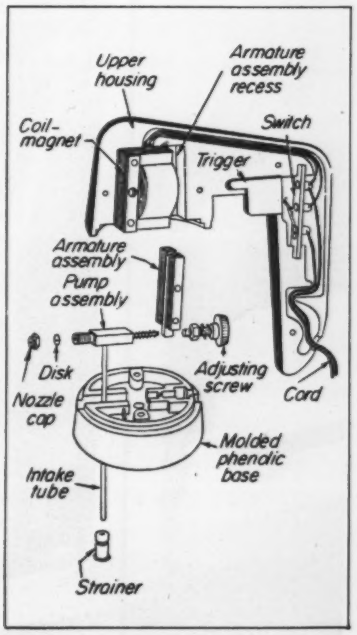
SPRING-adjusted toggle action releases at the preset torque on the wrench shown in the accompanying photograph. Giving an unmistakable indication to the operator when the desired tension has been reached, the wrench can be used in dark or crowded locations. As shown in the drawing, below, the torque value required is set by turning an adjusting nut until the correct tension is indicated on a scale on the spring housing or barrel. In tightening a nut or capscrew, the assembly composed of spindle, tension adjusting shaft and handle slides to the left in the spring housing against the spring compression. When the stipulated pull has been reached, i.e., anywhere up to 100 ft-lb, the toggle link snaps over center. Releasing the pull on the handle automatically resets the wrench. Manufacturer: Sunnen Products Co., St. Louis, Mo.



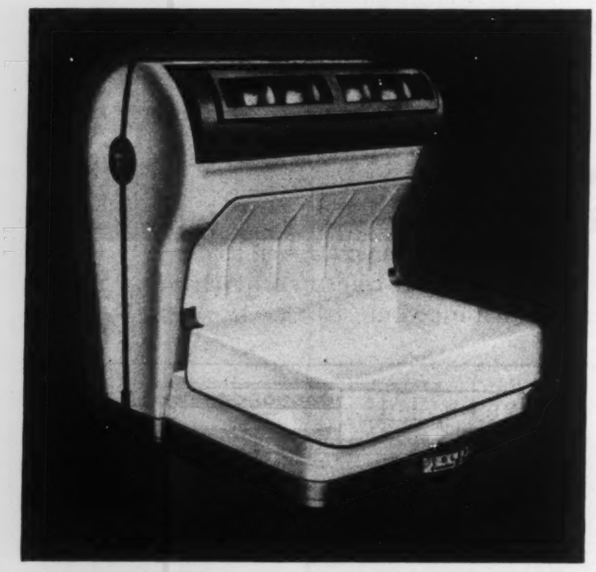

ft-lb
100
80
60
40
20
Drive shaft
Spindle
Spring housing
Torque scale
Spring
Handle
Adjusting nut
Toggle link

Vibrator Operates Portable Sprayer

A VIBRATORY armature furnishes power for operating the unique electric sprayer shown in the illustration, below. Requiring no air pressure, compressor or other auxiliary equipment, the sprayer weighs only 1¾ lb. The simple mechanism used to convert electrical energy into an adjustable spray can be seen in the exploded view, right. The upper housing contains a coil magnet and recess for the armature assembly. Reciprocating motion of the armature moves a plunger in the pump unit, adjustment for the size of the spray cone being made by a thumbscrew which limits the travel of the armature plunger and therefore varies the amount of liquid being sprayed. Entire operating mechanism of the inexpensive unit is enclosed in an easily cleaned, molded housing. Manufacturer: Burgess Battery Co., Chicago, Ill.

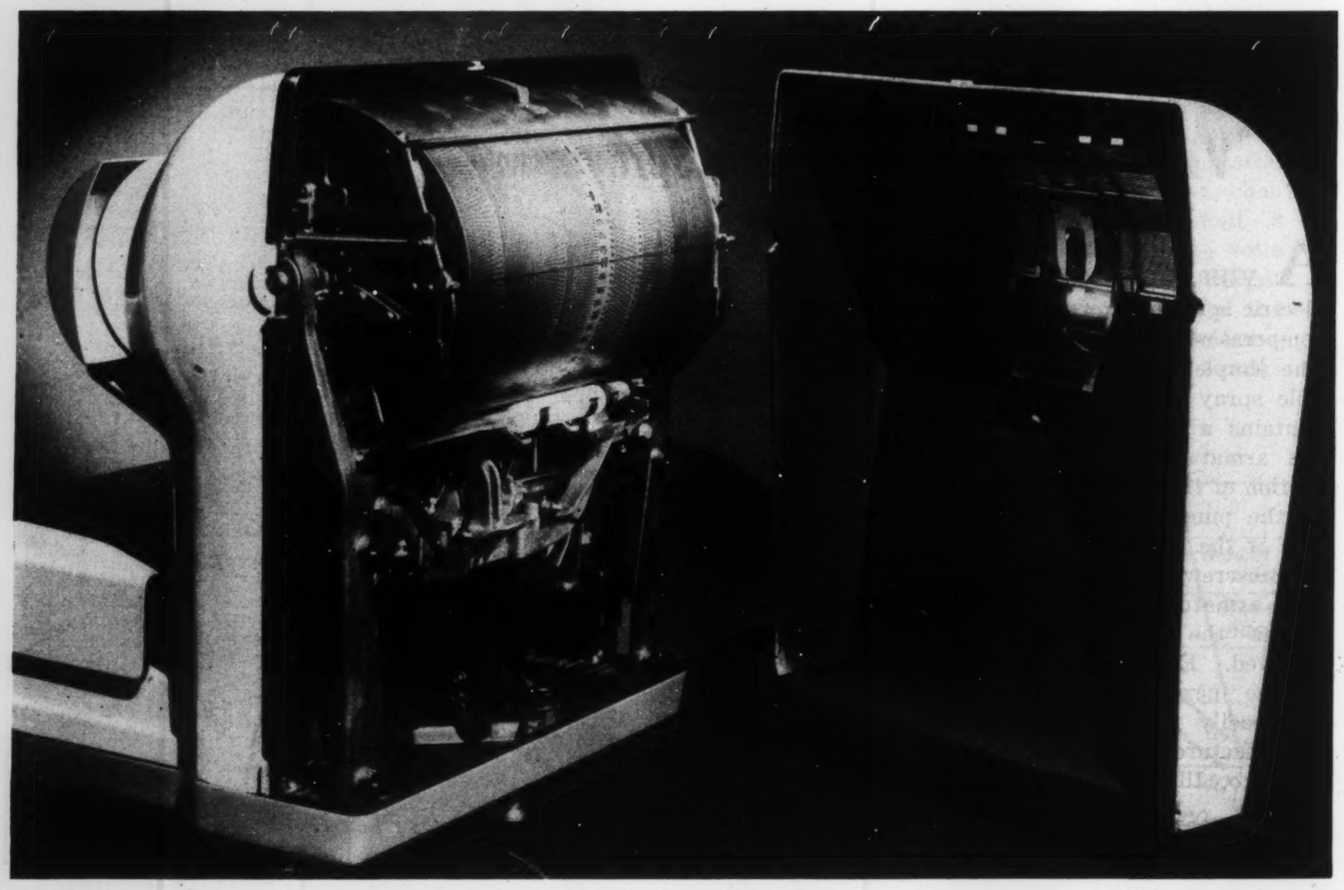

Upper housing
Armature assembly recess
Switch
Coil-magnet
Trigger
Armature assembly
Pump assembly
Disk
Nozzle cap
Adjusting screw
Cord
Molded phenolic base
Intake tube
Strainer

Plastic Housing Enhances Appearance of Scale



EYE-appealing use of plastics in modern machines is illustrated by the three-piece Plaskon housing on the Toledo Guardian 70 commercial scale shown in the photograph, left. A new double-pendulum mechanism that permits accurate weighing even with the scale out of level makes use of the same pendulum weights to counterbalance scales of different capacity. These capacity adjustments are made by moving the weights to different positions on sector rails, resulting in a weighing mechanism with uniform performance characteristics when equipped with either high or low capacity chart. Pendulum weights can be seen in the illustration, below. The photograph also shows the acrylic plastic light track used to "pipe" light from a source located at the base of the chart up to the customer's weight indication window.

An unusual feature of this scale is the use of four spherical lenses mounted in a sliding frame over the chart. These lenses magnify the price figures for easy reading and have the added advantages of permitting more computation characters to be included on the same space on the chart. Manufacturer: Toledo Scale Co., Toledo, O.



Calculating Stresses and Deflections in Circular Plates

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FORMULAS for calculating maximum stress and maximum deflection in constant-thickness circular plates with six different loading and edge conditions are presented in this data sheet.

Theory behind the formulas has been given by Timoshenko who has also presented formulas for eight other loading and edge conditions*. The data are subject to the following restrictions:

1. The plate is composed of a material which is elastically homogeneous and isotropic
2. The material follows Hooke's Law
3. Deflection of the plate is small compared to its thickness
4. Thickness of the plate is small compared to its diameter

The six cases covered by this data sheet are illustrated in the figure on Page 150, on which are indicated references to the appropriate equations in the text. Values of the coefficients to be used in the equations are listed in the table below.

Nomenclature

a = Outer radius of plate
b = Inner radius of hollow plate or, for a solid plate, the radius of the loaded region
E = Modulus of elasticity in tension and compression
M = Bending moment per unit arc length along the circumference of the plate
P = Total load concentrated along a circular arc
q = Normal load per unit area acting on face of plate
S = Bending unit stress
t = Thickness of plate
w = Deflection of plate.

In Cases 1, 2, and 3, where q is the intensity of loading, the maximum bending stress and the maximum deflection may be written in the forms

$$S_{max} = k \frac{qa^2}{t^2} \quad \text{.......} (1)$$

$$w_{max} = k_1 \frac{qa^4}{Et^3} \quad \text{.......} (2)$$

In Cases 4 and 5, where M is the moment per unit

Stress and Deflection Coefficients for Circular Flat Plates

a/b =	1.25		1.50		2		3		4		5	
Case	k	k_1	k	k_1	k	k_1	k	k_1	k	k_1	k	k_1
1	1.131	0.622	0.966	0.511	0.697	0.339	0.401	0.170	0.262	0.101	0.185	0.066
2	0.105	0.003	0.259	0.013	0.481	0.057	0.654	0.130	0.708	0.163	0.730	0.176
3	0.072	0.001	0.183	0.005	0.361	0.023	0.546	0.064	0.627	0.092	0.668	0.112
4	6	0.196	6	0.485	6	0.847	6	0.940	6	0.802	6	0.656
5	6.865	0.232	7.448	0.661	8.136	1.493	8.710	2.555	8.930	3.105	9.036	3.418
6	0.195	0.004	0.320	0.024	0.455	0.081	0.670	0.171	1.000	0.218	1.300	0.238

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* S. Timoshenko—*Theory of Plates and Shells*, McGraw-Hill Book Co. Inc., New York, 1940, Chapter III.

arc length, the maximum bending stress and maximum deflection become

$$S_{max} = k \frac{M}{t^2} \quad \text{(3)}$$

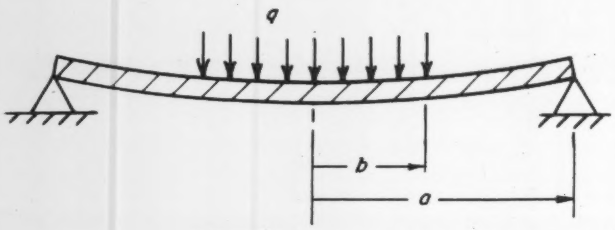
$$w_{max} = k_1 \frac{Ma^2}{Et^3} \quad \text{(4)}$$

For Case 6, with a load concentrated along a circular arc, the maximum bending stress and maximum deflection are given by

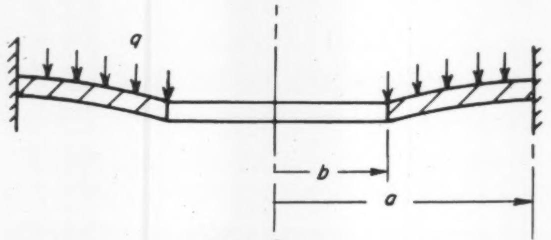
$$S_{max} = k \frac{P}{t^2} \quad \text{(5)}$$

$$w_{max} = k_1 \frac{Pa^2}{Et^3} \quad \text{(6)}$$

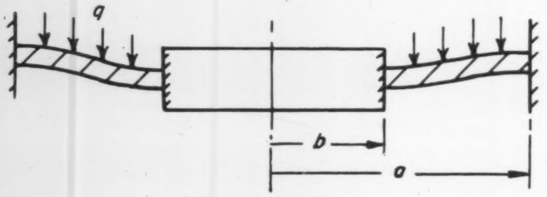
Values of k and k_1 for various values of the parameter a/b are given in the table on Page 149. Poisson's ratio is taken to be 0.3.



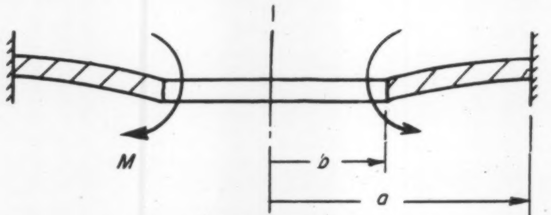
Case 1
See Equations 1 and 2



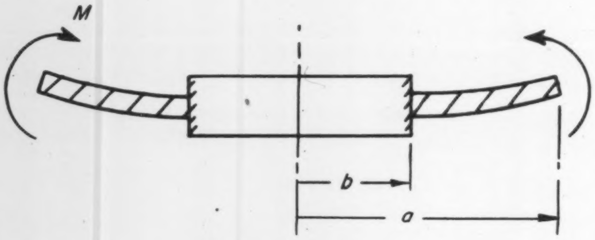
Case 2
See Equations 1 and 2



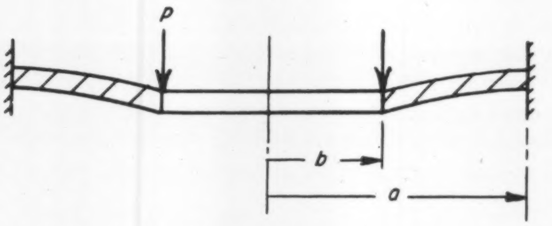
Case 3
See Equations 1 and 2



Case 4
See Equations 3 and 4



Case 5
See Equations 3 and 4



Case 6
See Equations 5 and 6

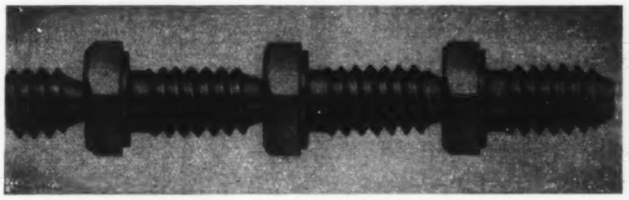
new parts and materials

For additional information on these new developments see Page 161

Multiscrew Fastenings

Consisting of one-piece stick of identical small screws, Screwsticks can be used in pneumatic, electric, spiral or hand-ratchet drivers for fast efficient multiscrew fastening. They can be obtained in diameters ranging from No. 4 to No. 5 in mild steel, brass and aluminum.

Constant measured torque provides uniform tightening, and screws are twisted off automatically when fastening is made and predetermined torque is reached. As tightened screw is freed from neck, next screw in line is automatically advanced and head of driven screw burnished by one to be driven. Manufacturer: American Screw Co., 1939 Nolan St., Providence 1, R. I.

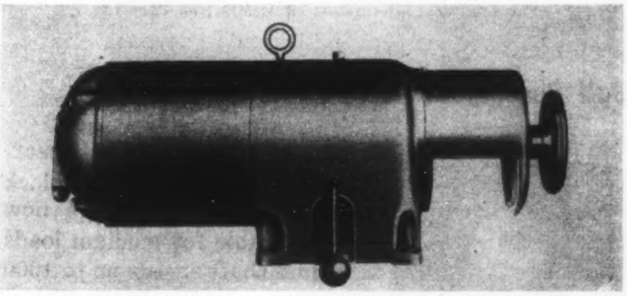


For additional information circle MD 1 on Page 161

Gearshift Drive

Combining integrally mounted motor and four-speed transmission, self-contained Selective-Speed gearshift drive is adaptable to many types of original production equipment requiring selective speeds.

Drive has gear ratio in low of 4.00 to 1; second, 2.00 to 1; third, 1.33 to 1; and high, 1.00 to 1. Unit is built with four speeds in ratings of 2 hp at 900 rpm to 10 hp at 1800 rpm and with eight speeds in ratings of 1½ hp at 1200/600 to 5 hp at 1800/900 rpm. By means of motor reversing control, it can be reversed instantly in all speeds.

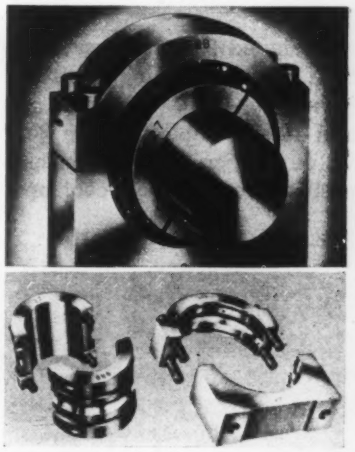


Four-speed drives are furnished for operation on 2 or 3-phase 25, 50 or 60 cycle 220, 440 or 550-volt a-c power supplies. Eight-speed drives operate on 3-phase 50 or 60-cycle 220, 440 or 550-volt a-c and can be supplied with either constant torque or constant horsepower motors.

Among features of drive are unit-cast gearbox, helical heat-treated gears, precision bearings, ample size oil reservoir equipped with magnetic drain plug, conveniently located gearshift lever and shifting diagram, and cast aluminum pulley guard. Safety type handwheel is provided for inching machine spindle and eliminates necessity of touching belt for any operation. Manufacturer: Lima Electric Motor Co., Lima, O.

For additional information circle MD 2 on Page 161

Pillow Blocks



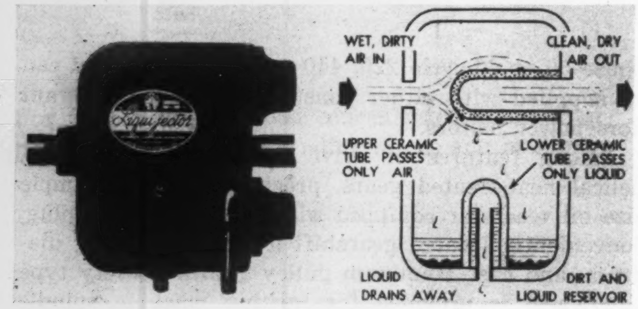
Suitable for use as replacement bearing or for inclusion in original equipment where bearing replacements are anticipated, these pillow blocks have both inner and outer races split or fractured and repositioned by holding screws. This construction permits assembly of bearing in places where solid race bearing cannot be installed. Replacing bearing, it can be assembled without stripping shaft or dismantling attached mechanism. With housing and outer race forged integrally from bearing steel, assembly is compact and has high load capacity because maximum complement of balls can be assembled as result of split construction. Blocks are supplied for shafts 15/16 to 3 15/16-inch in diameter. Manufacturer: Kohler Co., Kohler, Wis.

For additional information circle MD 3 on Page 161

Liquid Ejector

With water ejection rates varying from 0.5 to 2.5 gallons per 24 hours, Liqui-jectors can be utilized in precision pneumatic operations that require positive conditioning of air or gas. Typical applications are in liquid separation, agitation, drying, spraying, instruments and air-operated mechanisms. Ejector acts also as filter to remove atmospheric dirt and finely divided solid particles.

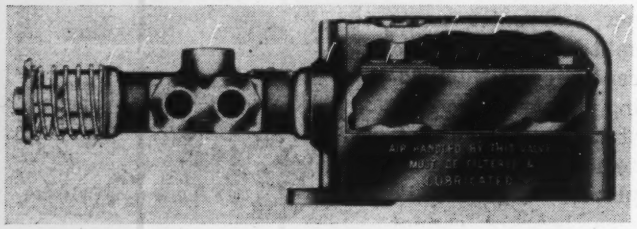
Phase separation and liquid ejection are accomplished by two ceramic tubes; one water-repellent, the other water-permeable but air impervious. Compressed air or other gas passes through first tube where it is stripped of its aqueous contamination and dirt. Moisture drops to bottom and drains through second tube without loss of air. Manufacturer: Selas Corp. of America, D. St. & Erie Ave., Philadelphia 34, Pa.


Aquijector
WET, DIRTY AIR IN
CLEAN, DRY AIR OUT
UPPER CERAMIC TUBE PASSES ONLY AIR
LOWER CERAMIC TUBE PASSES ONLY LIQUID
LIQUID DRAINS AWAY
DIRT AND LIQUID RESERVOIR

For additional information circle MD 4 on Page 161

Electric Air Valves

Designed for air pressures up to 125 psi, spring-return single-solenoid valves are supplied in sizes of ¼, ⅜ and ½-inch. All sizes are available for 110, 220 and 440-volt operation on 25, 50 and 60-cycle current. Valve has one-piece bronze base, heavy solenoid for positive seating and cool operation, and heavy sheet metal cover. Type OU packer is used as well as shock-resisting clevis and clevis pin. Models are available in two-way, three-way open end exhaust, three-way piped exhaust and four-way piped exhaust types supplied in all sizes. Manufacturer: Valvair Corp., 454 Morgan Ave., Akron 11, O.



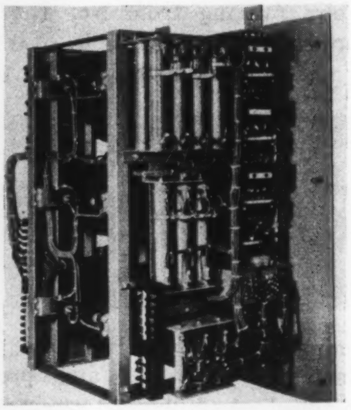
For additional information circle MD 5 on Page 161

Inlaid Circuits For Sliding Contacts

Especially suited for sliding contacts, inlaid circuits consist of electrical conductors having their surfaces flush with the surface of the surrounding insulation. They can be used as miniature tap switches, commutators, potentiometers and variable resistors. High conductivity, fineness of detail, firm anchorage and the minute size attainable make them suitable for all electrical elements and miniaturization where high performance are required. The body of the conductor may be made of one metal and the surface of another thus providing desired degree of corrosion or abrasion resistance. Pattern may be metal inlaid in an insulator or metal inlaid in another metal. Any desired size and pattern can be provided. Manufacturer: Glass Products Co., 108 North Dearborn St., Chicago 2, Ill.

For additional information circle MD 6 on Page 161

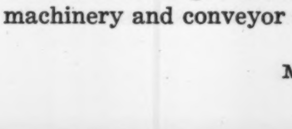
Static Generator Voltage Regulator



Designed to withstand shock and vibration by eliminating the use of the vacuum tube, static regulator is an electrical unit which supplies power to and automatically adjusts generator field current to a value required to maintain constant generator voltage. Power supplied by the regulator is obtained from the a-c output of the generator. This power is in turn converted from a-c to d-c for the generator field by a selenium rectifier. In addition to being a voltage regulator, the static regulator may be considered an a-c generator capable of self-excitation. The regulator is self-contained except for the voltage control unit, automatic transfer switch, and the current and reactive droop compensation transformers which may be mounted in the switchboard cubicle. Output of voltage supplied to the field is 30 amperes at 70 volts, overload rating is 150 per cent (4000 watts) overload for 30 seconds, and the transient response time is 8 cycles based on 400 cycles per second. Manufacturer: Vickers Electric Div., 1815 Locust St., St. Louis 3, Mo.

For additional information circle MD 7 on Page 161

Ball Bearing Units

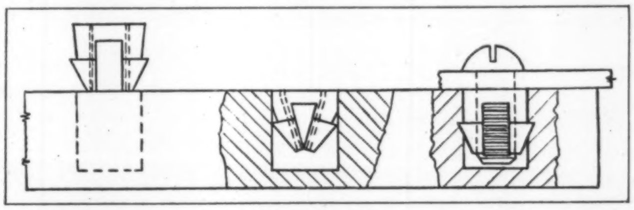


New series of ball bearing units, both pillow block and flange type, are now available for medium loads and shaft speeds up to 1000 rpm and can be furnished in sizes for shafts from ½ to 1½ inches in diameter. Ball bearing units are designed to allow for normal misalignment of the shaft. Bearings move in alloy steel races and the inner race is locked on the shaft by two set screws spaced 90 degrees apart. Pillow blocks and flange units are recommended for farm machinery and conveyor equipment as well as all anti-friction work at low speeds and light loads. Manufacturer: Roberts Machine Works, 1619 Hennepin Ave., Minneapolis 3, Minn.

For additional information circle MD 8 on Page 161

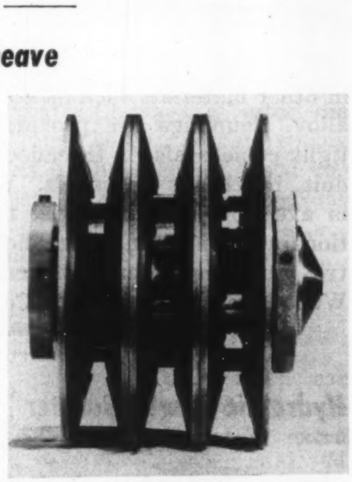
Screw Locking Insert

Developed for plastics and other nonmetallic materials these inserts provide a tapped hole which locks the screw against loosening from vibration. No special tools are necessary. As the insertion of the screw expands these inserts, sharp corners cut into the work and form keyways against which they cannot turn and the locking drag on the screw is determined by the diameter of the hole drilled into the work. Screw locking inserts are furnished in brass, 3/16-inches long for use in all thicknesses of material from 3/16-inches up. They are made of any metal and furnished in special lengths for use with special screws and are available for all sizes of screws. Manufacturer: Brush Nail Expansion Bolt Co., Greenwich, Conn.



For additional information circle MD 9 on Page 161

V-Belt Maxi-Pitch Sheave

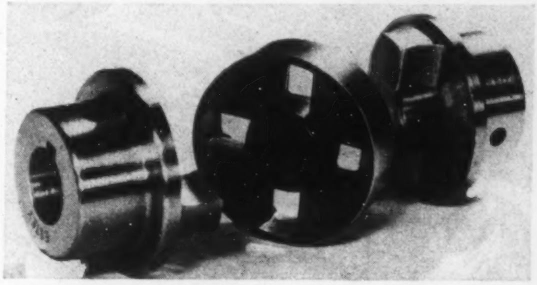


Maximum pitch diameter variation, approximating 250 per cent of the width of the belt section used, is made possible with this sheave by interlocking splined surfaces at the bottom of the groove. This allows maximum movement of flanges toward and away from each other and increased speed control over the machinery's top and bottom limits. Handwheel controls the pitch variation for belt sections used and positive friction lock is accomplished by tightening one screw. Manufacturer: V-Belt Engineering Co., Aspen Ave., Richmond, Va.

For additional information circle MD 10 on Page 161

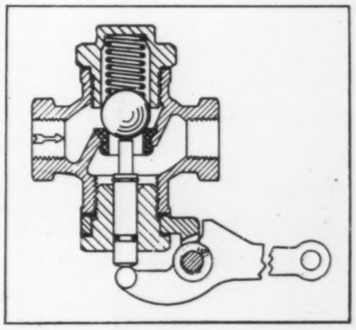
Flexible Coupling

Employing steel-banded synthetic rubber spider which withstands high temperature and is completely oil-resistant, this articulated flexible coupling compensates for both parallel and angular misalignment, does not require lubrication and runs silently. Steel spider ring allows coupling to operate at high speed without damage or breakdown from torque and centrifugal force. Concave-surfaced steel driving lugs fit into convex-surfaced cavities of spider and compress rubber to minimize vibration. Unit has highly finished steel surface to prevent injury from accidental contact with coupling while in motion. Manufacturer: Estey Co., 547 N. Main St., Canandaigua, N. Y.



For additional information circle MD 11 on Page 161

Air-Water Operating Valve



Adaptable to service where fast, positive action and tight closing are necessary, this Type BA-1 self-sealing air or water operating ball-type valve is fitted with quick-opening lever which can be adjusted to any horizontal position. Ball valve closes tight with inlet pressure and will not collect dirt or other foreign matter. Stem is sealed by O-ring which is not accessible to tampering or adjustment.

Valve is suitable for use with air, water and other fluids of noncorrosive nature up to 200 pounds per square inch pressure and temperatures up to 150 F air and 180 F water. Valve is constructed with cast semisteel body, integral rubber seat insert and screwed connections of ½-inch size which can be bushed to ¼ or ⅜-inch. Manufacturer: Leslie Co., 341 Delafield Ave., Lyndhurst, N. J.

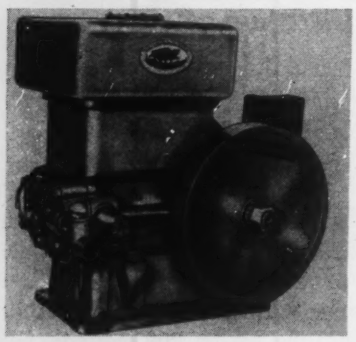
For additional information circle MD 12 on Page 161

Hermetically Sealed Relays

Sealed in a controlled atmosphere of dry, inert gas, relays are protected from the effects of moisture, ice, dust, fungi, salt and varying air pressure. Because they are enclosed in metal housings, the relays are tamper-proof; they satisfy the requirements of temperature, humidity and immersion tests as described in current armed forces specifications. Many types of relays are available for hermetic sealing in various sizes and shapes of enclosures. Relays available will accommodate operating potentials from one to several hundred volts. Contact ratings can vary from a few milliwatts to several hundred watts. Operation time is from one to 100 milliseconds; release time from 5 to 500 milliseconds. Manufacturer: Automatic Electric Sales Corp., 1033 W. Van Buren St., Chicago 7, Ill.

For additional information circle MD 13 on Page 161

Water-Cooled Engine

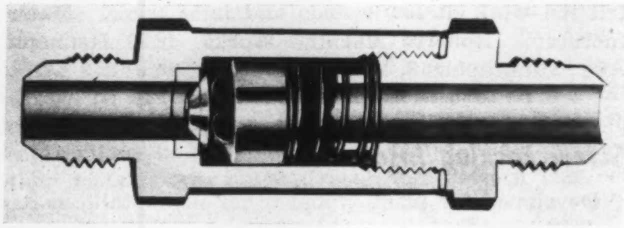


Particularly adaptable for powering mixers, pumps and other equipment requiring slow speed and high torque, model R40 cub water-cooled engine is a single-cylinder, four-cycle, horizontal type. With 56.6 cubic-inch displacement, engine develops up to 34 lb-ft torque and 6 horsepower at operating range of 700-1000 rpm. Largest of four models in the line covering 2.5-6 horsepower range, engine is compact, fully enclosed and self-lubricated and can operate on distillate, tractor fuel, gasoline, natural gas or kerosene. Other features include heavy adjustable taper roller main bearings, throttling type governor and high tension make-break type magneto. Manufacturer: Cushman Motor Works Inc., Lincoln 1, Neb.

For additional information circle MD 14 on Page 161

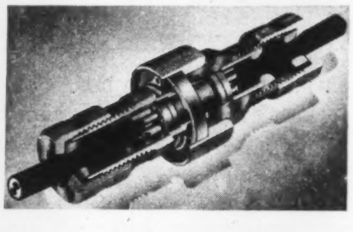
High Pressure Check Valve

Cone type check valves which are suitable for high pressure, extreme temperatures and corrosive fluids can be obtained with aluminum bodies for pressures up to 1500 psi. Tube connections in sizes from ⅛ to 1 inch outside diameter are carried in stock. Valves meet Army-Navy specifications which involve high and low temperature functioning, leakage tests from 1 to 3000 psi with no allowable leakage over 1000 pounds per square inch, endurance tests of 50,000 cycles, pressure drop in sizes ¼ to 1 inch averaging 10 psi, and checking time of less than ½-second. Manufacturer: Kohler Co., Kohler, Wis.



For additional information circle MD 15 on Page 161

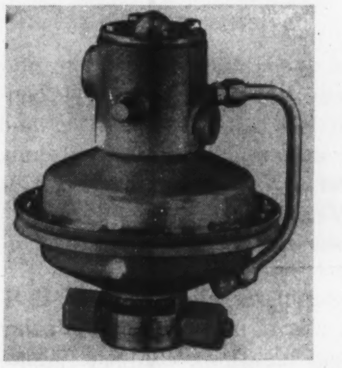
Waterproof Coupling



Designed for all-weather and submarine uses, 1600 series type electrical coupling is quick acting, vibration-proof and of heavy-duty type. Capable of withstanding long periods of complete immersion under high external pressure without leakage, coupling can be used in electronic, marine and geophysical applications. Quarter turn makes or breaks coupling without use of tools. Coupling is manufactured from bronze alloys in wide range of sizes and can be supplied also in other materials such as stainless steel or aluminum alloy. Couplings are provided either with pressure-tight cable seals or threaded for attachment to conduit, bulkheads or panels. Wide selection of inserts is available, manufactured to Army-Navy specifications and employing phenolic material of high dielectric qualities. Manufacturer: Roylyn Inc., 718 W. Wilson Ave., Glendale 3, Calif.

For additional information circle MD 16 on Page 161

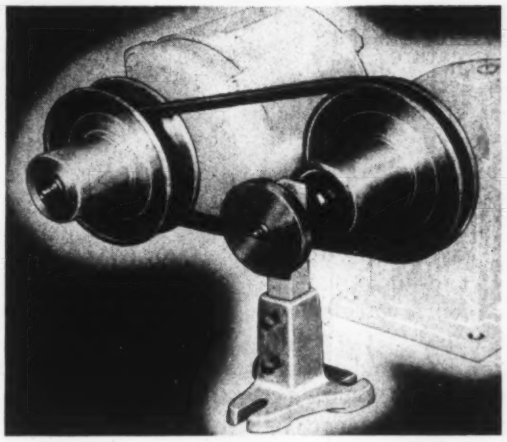
Hydraulic Power Booster



Operating on 100-psi plant air supply, model C-R hydraulic booster pump power unit is capable of providing hydraulic pressures ranging from 1000 to 30,000 psi. This unit is recommended for powering presses, clamping devices, shears, static testers, jacks and pullers. Unit weighs 20 pounds, is 10 inches high and has 8-inch outside diameter. Supplied complete and ready for installation with reservoir, pressure gage and necessary control valves. Although this unit is designed primarily for oil service, other models are available with special bronze or stainless steel parts for water service or other corrosive liquids. Manufacturer: Sprague Engineering & Sales, 1144 W. 135th St., Gardena, Calif.

For additional information circle MD 17 on Page 161

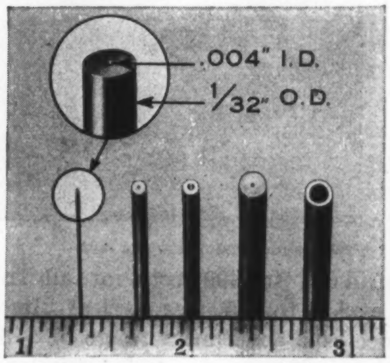
Variable Speed Drive



Providing 6:1 ratio with one standard B-section V-belt on fixed centers at any distance, variable-speed control unit can be used to replace fixed sheaves on machines up to 1 hp. Assembly consists of two variable-pitch sheaves having 2.45:1 pitch variation and regulating mechanism to open and close control sheaves. Spring-loaded sheave is mounted on motor shaft while manually adjusted control sheave is mounted on driven shaft. Changes in pitch diameter of driven sheave cause belt to actuate spring-loaded motor sheave thus giving stepless speed control. Manufacturer: Speed Selector Inc., 118 Noble Court, Cleveland 13, O.

For additional information circle MD 18 on Page 161

Cemented Carbide Tubes

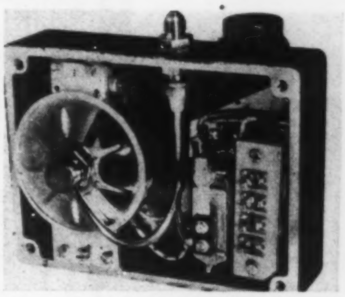


Cemented carbide tubes manufactured by extrusion methods are available in sizes as small as 1/32-inch outside diameter with inside diameter of 0.004-inch and as large as 9/16-inch outside diameter with wall thickness of 1/16-inch. Outside diameter is rough extruded 0.010 to 0.015-inch oversize, and inside diameter is held to within 1 per cent of specified size and is completely concentric.

Tubes are supplied in two classes of Kennametal. One is straight tungsten carbide, having hardness combined with strength. It is suitable for parts subjected to abrasion at normal temperatures such as wire and thread guides, gage elements and punch and die parts. The other is essentially titanium carbide, having hardness comparable to that of tungsten carbide but weighing much less. It withstands corrosion and abrasion at elevated temperatures that rapidly disintegrate cast alloys. Its transverse rupture strength at 1800 F is 100,000 psi. Manufacturer: Kennametal Inc., 171 Lloyd Ave., Latrobe, Pa.

For additional information circle MD 19 on Page 161

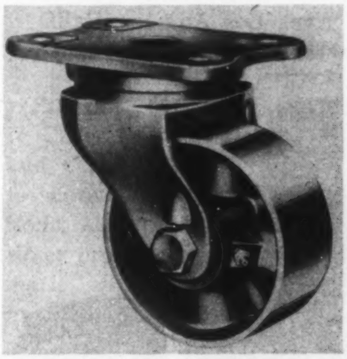
Nil-Pressure Actuated Switch



Nil-pressure actuated switch for use as a safety measure or as a positive control of electromechanical devices by fluid pressure features a pressure response element that operates an electric switch at a pressure as low as 0.1-inch of mercury above ambient and yet withstands a static pressure of 150 psi. Use of a relay and Microswitch confines the load on the switch to the current required to actuate the relay. Relay contacts are of adequate capacity to actuate most preventive and control mechanisms. Manufacturer: Meletron Corp., 950 North Highland Ave., Hollywood 38, Calif.

For additional information circle MD 20 on Page 161

Heavy Duty Casters



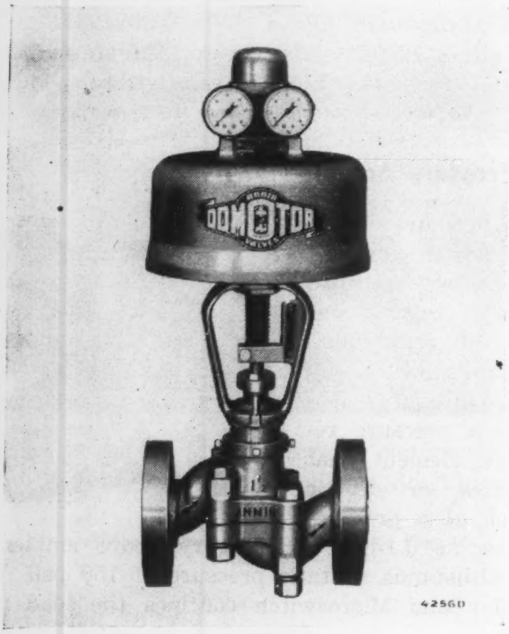
Forged steel heavy-duty casters in 5, 6 and 8-inch wheel diameters are recommended for operating loads of 1500 to 2000 pounds per caster. Main load bearings are fully enclosed, and Timken thrust bearings assure ease of turning under full load. They will carry safely practically any load that can be moved on given wheel size. Manufacturer: Bassick Co., Bridgeport, Conn.

For additional information circle MD 21 on Page 161

Control Valve

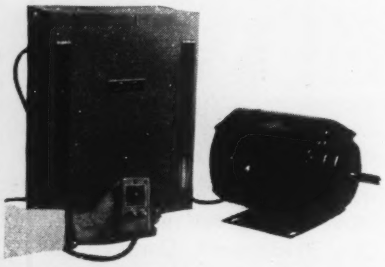
Large flow capacity resulting from absence of pockets or shoulders which ordinarily accumulate solids, and use of threadless assembly make Domotor control valve especially suitable for handling erosive, corrosive and viscous liquids. Two body parts of valve can be rotated about seat ring to form right-hand angle, left-hand angle or straight-through pattern; addition of simple straight adapter produces conventional angle pattern body.

Valve can be obtained in such materials as cast steel, type 316 stainless steel, Durimet 20, solid nickel, Hastelloy B and C and almost any castable alloy on special order. It is powered by piston type actuating unit which utilizes longer strokes than standard and which has inherent stabilizing factor. Integral valve positioner unit is housed within dome of power unit and is connected with moving mechanism only by frictionless spring. It is completely concealed to prevent unauthorized tampering and does not require any field adjustments. Manufacturer: Annin Co., 3234 Mines Ave., Los Angeles, Calif.



For additional information circle MD 22 on Page 161

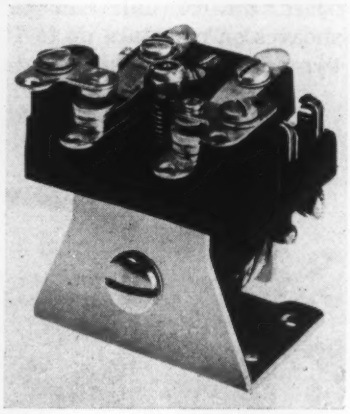
Stepless Speed Control



System for the stepless speed control of fractional-horsepower motors has been developed. Simplified circuit is used which makes possible an electronic control system capable of operating from either a 110 or 220 volt (50-60 cycles) a-c power source. The power unit utilizes full wave gaseous rectification to supply both the armature and field of a specially designed, ball bearing, d-c motor. Control unit, which can be at considerable distance from either the motor or power unit, permits the selection of any desired speed over a range greater than 20 to 1 (80 to 1800 rpm standard.) Other speed ranges are available. Included on the control unit is an "idle" switch to start or stop motor without changing the speed setting. Reversing control units can be furnished. Two models are available which include various type motors up to and including ½-hp. Most types can be supplied immediately. Manufacturer: Servo-Tek Co., 4 Godwin Ave., Paterson 1, N. J.

For additional information circle MD 23 on Page 161

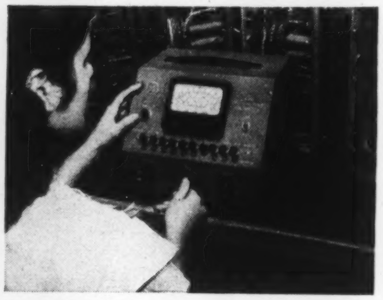
General Purpose Relay



Available for any operating voltage up to 300 volts d-c or 440 volts a-c, this general purpose relay has armature and frame designed for perfect operation under extreme vibration and shock conditions. Metal parts are heavily plated with cadmium or nickel, and universal wound coil is varnish impregnated. Contacts on all standard units are ¼-inch diameter pure silver, rated 115 volts a-c or 24 volts d-c noninductive. Six contact combinations are available up to double-pole double-throw. Contacts of special alloys for higher loads are available. Small size of relay allows use for all types of plug-in or hermetically sealed requirements. Manufacturer: Advance Electric & Relay Co., 1260 W. Second St., Los Angeles 26, Calif.

For additional information circle MD 24 on Page 161

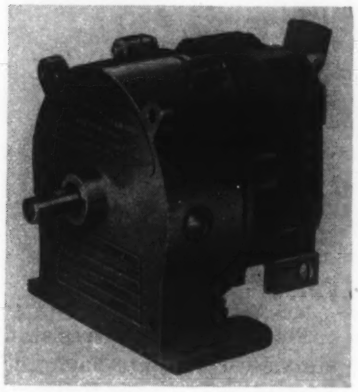
Vacuum Tube Voltmeter



Designated as Type AA-1, vacuum-tube voltmeter for measuring voltage in electronic and other low-energy circuits where minimum current drain is desirable is available. The instrument has a calibrated range of 0.001 to 300 volts at all frequencies from 10 cycles to 1.5 megacycles. It is also graduated in decibels, covering a range of −52 to +52 decibels from a reference level of 1 milliwatt at 600 ohms. A ten-position pushbutton switch permits any working range to be selected without passing through intermediate ranges. Suitable for either portable or bench use, voltmeter is housed in an aluminum case having a sloping front panel which supports the indicating instrument. Terminals for wires or standard banana jacks are provided for connection to the measured circuit. Manufacturer: General Electric Co., Schenectady, N. Y.

For additional information circle MD 25 on Page 161

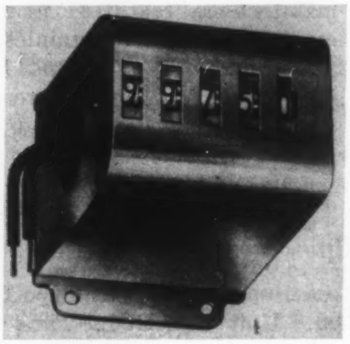
Gearhead Motor



Vending machines, phonograph turntables and window displays can be operated with type Z gearhead Micromotor which has output selections almost without limit down to 2 rpm. It is powered by quiet running two-pole offset motor with single bearing lubricated from gear box. Brake device can be supplied if required. Four mounting holes are provided horizontal to shaft on front surface and four vertical to shaft on base surface. Unit weighs 36 oz and measures 3 7/32 x 3 11/32 x 3⅝ inches including shaft. Manufacturer: Redmond Co., Owosso, Mich.

For additional information circle MD 26 on Page 161

Low-Speed Magnetic Counter

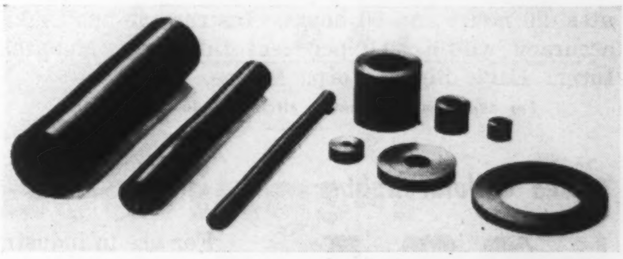


Five large bold figures assure ease of reading this series 1268 magnetic counter. It is intended for installations which do not require high number of counts or counting speeds in excess of 50 per minute. Compactly designed, counter can be built into equipment or machines as integral mechanism. Standard construction includes coil for operation on 110-volts a-c, but coils for use on 24-volt a-c or d-c or 110-volt d-c can be supplied. Actuated through electromagnet, counter can be connected in series with any device having contact arrangement. Manufacturer: Veeder-Root Inc., Hartford 2, Conn.

For additional information circle MD 27 on Page 161

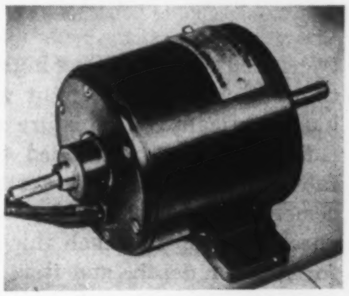
Graphite-Filled Nylon

Particularly well suited for use as dry bearings, Nylatron G graphite-filled nylon can also be used for cams, cam followers, gears, washers, oil seal rings and valve and pump packing. Material is furnished in rod diameters from 0.100 to 2¾ inches, in cylinders from 2 to 7 inches outside diameter with varying wall thicknesses, and in strip from 0.010 to 0.090-inch in widths up to 2 inches. It is generally applicable to conditions involving combination of rubbing and impact or where normal lubrication is impossible. Manufacturer: Polymer Corp., Reading, Pa.



For additional information circle MD 28 on Page 161

Direct Current Generator



Small direct current generators deliver output voltage which is proportional to acceleration of rotor rather than to velocity of rotation. They are useful in servo systems having damping problems and in systems where it is necessary to measure or limit acceleration. With current of 0.120-amp in 350-ohm field, generators deliver 0.1-volt for acceleration of 1400 radians per second squared. Maximum speed is 5000 rpm with rotor inertia of 0.25 ounce inches squared. Unit weighs 3 pounds and has overall length exclusive of shaft of 3⅜ inches. Manufacturer: Arma Corp., 253 36th St., Brooklyn 32, N. Y.

For additional information circle MD 29 on Page 161

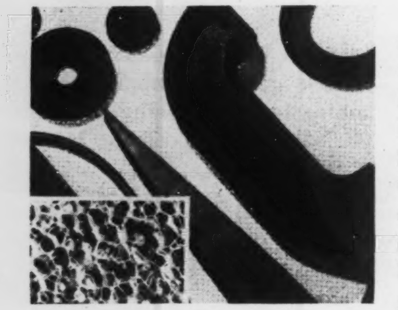
Automatic Control Timer

Suitable for use in Class I Group D and Class II Group G hazardous locations, Microflex timer provides automatic timing for many processing applications to insure uniform quality. Because cast-iron enclosure has machined metal-to-metal seal, timer can be used for controlling electrically operated valves and motors where atmosphere contains explosive mixtures of gasoline, petroleum, lacquer solvent vapors and natural gas.

Timer has micrometer dial mounted on cover of case where it is easily adjustable and clearly visible. Standard dials are 120 seconds, 20 minutes, 120 minutes, 20 hours and 60 hours. Instrument has timing accuracy within 99.9 per cent full scale. Manufacturer: Eagle Signal Corp., Moline, Ill.

For additional information circle MD 30 on Page 161

Closed Cellular Rubber

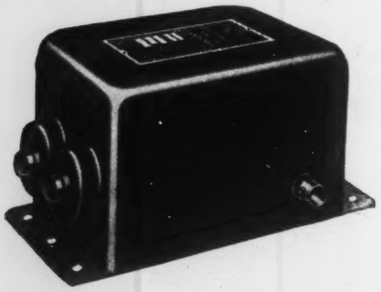


For use in industry transportation and consumer products, Rubatex cellular rubber is composed of minute cells filled with nitrogen and each individually encased in wall of rubber. Because there is no escape of nitrogen or interchange between cells, material has high degree of resilience, low thermal conductivity, light weight and buoyancy. It has practically no moisture absorption.

Material can be molded to any desired shape or fabricated through die-cutting, stamping, splitting, cementing and other methods. It is obtainable in sheet form up to 1-inch thick which can be laminated for greater depth, and it is offered in either natural or synthetic rubber in wide ranges of color. Manufacturer: Great American Industries Inc., Rubatex Div., 230 Park Ave., New York 17, N. Y.

For additional information circle MD 31 on Page 161

Oil Burner Ignition Transformer

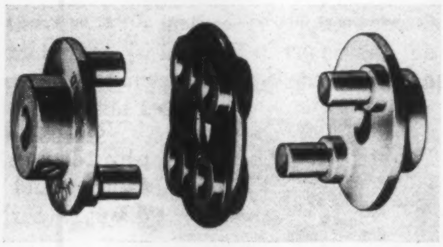


Oil burner ignition transformer provides a secondary current of intensity sufficient to ignite low viscosity and residential fuel oil. Cores of the unit are constructed of high grade silicon steel laminations and assembled with vacuum impregnated coils which are installed in a waterproof, splashproof casing and sealed in heat and moisture resisting compound. It is claimed that the transformer when operating will not cause a disturbance in the electrical circuit to affect radio or television reception. Manufacturer: Acme Electric Corp., N. Y.

For additional information circle MD 32 on Page 161

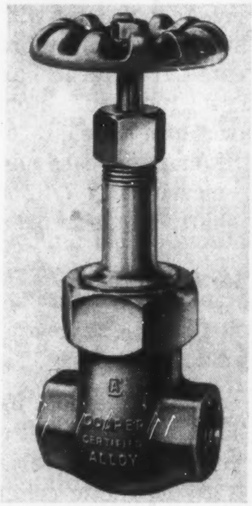
Flexible Coupling

Mighty-Midget all-rubber-center coupling designed for power transmission in fractional horsepower motors is addition to Morflex line. Neoprene center member gives coupling long service life because flexing caused by misalignment is absorbed by entire center member. Tight fit of couplings when pressed into rubber center reduces noise and vibration and cushions shock load. Manufacturer: Morse Chain Co., 7601 Central Ave., Detroit 8, Mich.



For additional information circle MD 33 on Page 161

Stainless Steel Gate Valve

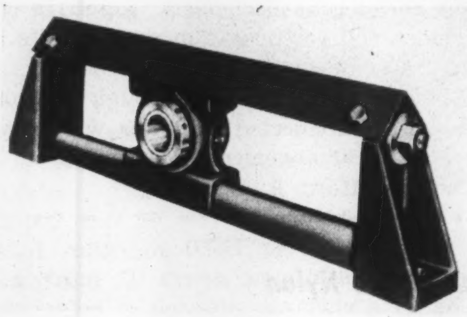


This corrosion - resistant stainless steel gate valve, developed to satisfy demand for a small size stainless valve, is simple in design, featuring such construction items as union bonnet design, ball and socket point contact disks which adjust themselves in any position, and a minimum of six turns of packing to assure effective sealing. A low-cost valve with simplified maintenance features, it is available in various stainless alloys and in ½, ¾, and 1-inch sizes. Manufacturer: The Cooper Alloy Foundry Co., Bloy St. & Ramsey Ave., Hillside, N. J.

For additional information circle MD 34 on Page 161

Roller-Bearing Take-Up

Sturdy roller bearing take-up, identified as Type E, is of welded construction. Unit uses Dodge-Timken Type E roller-bearing pillow blocks, and provides positive take-up by means of screw heads at either end. Adjusting screws are plated and a structural-angle top member provides effective protection against dust and dirt. A wide range of sizes are available. Manufacturer: Dodge Mfg. Corp., Mishawaka, Ind.



For additional information circle MD 35 on Page 161

JOHNSON BRONZE

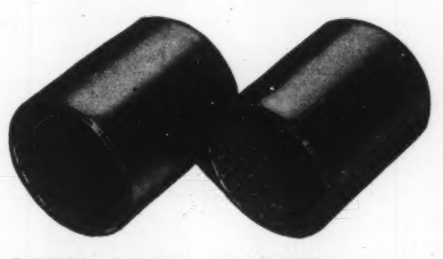
SLEEVE BEARING DATA

Bearing TYPES

JOHNSON BRONZE

SLEEVE BEARING DATA

Sheet Metal Bearings-1



SHEET METAL BEARINGS, sometimes referred to as either thin wall, rolled-up, slip-in, split or laminated, are available in four different types, i.e.:

1. Bronze sheet metal
2. Bronze-on-steel
3. Steel and lead babbitt
4. Steel and tin babbitt

They are comparatively low in price . . . particularly when there is quantity of a size . . . yet high in efficiency, possessing many unusual bearing qualities. With the exception of certain automotive replacement parts, sheet metal bearings are not stock items but are made to specifications determined by the requirements of the application.

Bronze Sheet Metal

The necessity for ductility limits bronze sheet metal bearings to two alloys, containing not more than 4% lead and 4% tin. Higher percentages of these metals would render the material too hard for rolling. As listed below, Johnson's alloy No. 44 is the highest grade and comes closest to plastic bronze. Due to the limitations of the elemental constituents these two alloys have a higher coefficient of friction and not quite as great load carrying capacity as cast bronze. However, the rolling operation imparts a dense structure to the metal which results in excellent resistance to pounding and to shock. The degree of hardness can be furnished as specified.

Bearings made of number 40 alloy should be burnished in place as the metal has low machining qualities; however, number 44 alloy can be burnished, bored or reamed in assembly.

The most common wall thicknesses are 1/32" and 1/16", with a variation of .005" plus or minus from the nominal size. One of the advantages of limiting the wall thickness to 1/16" is that the bearing can be easily seated in place by burnishing. Oil holes, slots or grooves are easily added during the fabricating process.

Bronze Sheet Metal bearings are excellent for applications where motion is comparatively low and impact is the main factor. They are also ideal and most economical for use where atmospheric or gaseous conditions may corrode cast iron or steel.

	Johnson Alloy No. 40 S.A.E. 795	Johnson Alloy No. 44 S.A.E. 791
COPPER	90.0%	86/90%
TIN	0.5%	3.0/4.5%
LEAD		3.5/4.5%
ZINC	9.5%	3.5/5.0%
HARDNESS ROCKWELL B	65-71—1/16 Ball 100 KG. LOAD	

Burnishing is desirable in all cases when possible for it imparts a dense smooth bearing surface, seats the bearing in place properly and renders the bore uniform. The common stock allowance for burnishing is .002" to .004".

If bearings are to be used in cast iron housings, or other types which may not be strong enough to permit a burnishing operation, it is recommended that a material be used possessing good reaming properties. Sometimes it is necessary, due to design of application, to ream two or more bushings in line. Reaming stock allowance should be about .006" to .009".

In cases where any doubt exists regarding the best method of sizing sheet metal bearings in assembly, it is advisable to submit complete data to our engineers. We will draw on our vast experience and give you a straight-forward answer for your particular problem without obligation. In some cases we often find it advisable to submit samples for test application in order to be absolutely certain that the correct solution has been found before fabrication of the complete order.

Points to remember when ordering

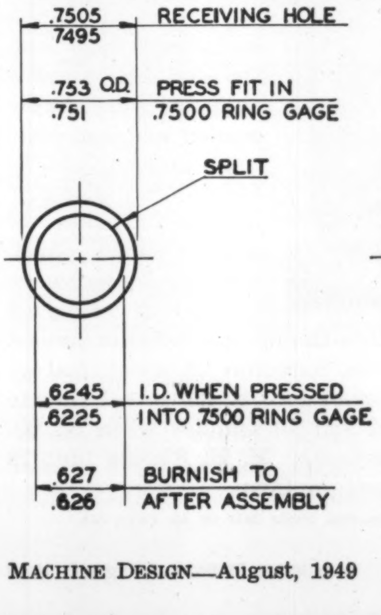
1. Housing hole size and housing material.
2. I.D. required after finishing in assembly.
3. Method of finishing I.D.
4. Shaft diameter and tolerance.
5. Special features such as grooves and holes should be specified.

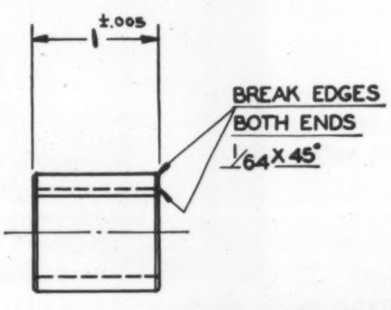
Thrust Washers

Bronze sheet metal is an ideal material for various types of washers, thrust plates and other flat pieces. As such it is available either in the form of the completed product, made to exact specifications or in rolls for fabrication by the user. This material can be secured either plain, serrated for graphite, or ball indented for the retaining of grease.

Johnson engineers are always available for consultation on all types of bearing problems. Their advice is available without obligation.

●





Typical Specifications

.751—.753 is the O.D. of the bearing measured by pressing the bearing into a press fit ring gauge having size equal to mean housing bore size. One-quarter inch of the bearing is left extended from the ring gauge and miked.

This bearing data sheet is but one of a series. You can get the complete set by writing to—

Johnson Bronze

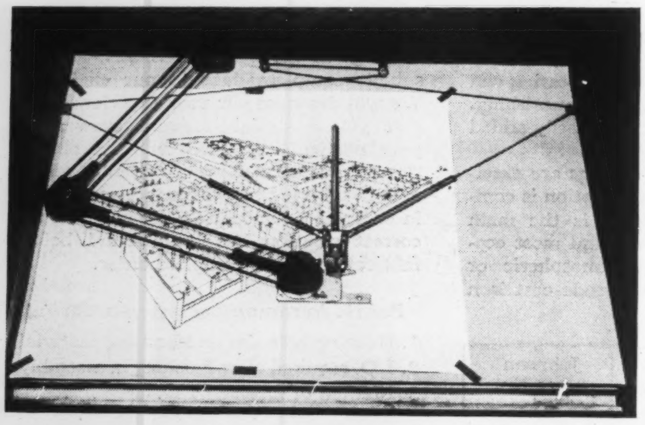
SLEEVE BEARING HEADQUARTERS
525 S. MILL ST. • NEW CASTLE, PENNA.

engineering dept equipment

For additional information on this new equipment see Page 161

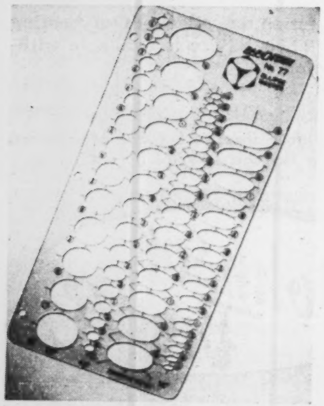
Perspective Drafting Guide

Making it comparatively simple matter to create perspective drawings, Perspect-O-Metric drafting instrument automatically guides draftsman's pencil toward established vanishing point from any position on drawing board. Instrument attaches to any standard drafting machine and can be adapted also to parallel ruling straight edges. It has three scale arms with special scales to reduce distant portions of subject to their correct proportions. Central arm is fixed in position at right angles to established base line, and left and right scale arms pivot at one end and swing in plane of drawing board. Any movement of this device creates corresponding angular motion of swinging scale arms; consequently, no matter where instrument is placed on board, scale arms remain oriented to chosen vanishing points. Manufacturer: Charles Bruning Co., 4754-6 Montrose Ave., Chicago 41, Ill.



For additional information circle MD 36 on Page 161

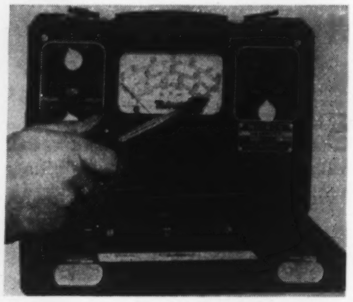
Ellipse Master Template



Featuring sixty true isometric ellipses projected from an angle of 35 degrees 16 minutes and ranging from ¼ to 1⅜ inches in size, No. 77 ellipse master template is milled from 0.030-inch mathematical-quality plastic with axes and sizes indelibly printed on the face. Matte finish has been employed for contrast and minimum glare. Applicable to all axonometric drawings, the template has three ring binder holes for notebook use. Actual size is 5 by 10 7/16 inches. Manufacturer: Rapidesign Inc., Glendale, Calif.

For additional information circle MD 37 on Page 161

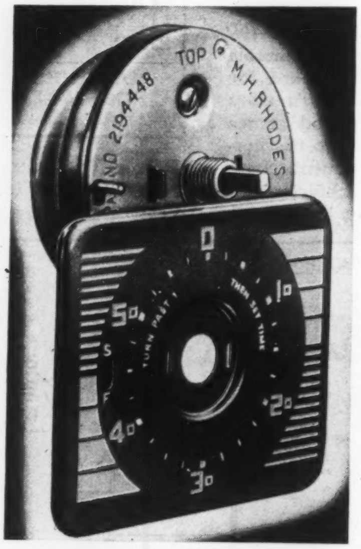
Motor Testing Tachometer



Recommended for production testing synchronous or induction motors, gear motors and generators, type 48K precision tachometer has total speed range without adapters of from 360 to 4000 rpm. Head adapters can be obtained for checking high speed universal or extreme low speed gear motors. Any one of ten ranges can be selected by rotary switch, and no damage results from overspeeding up to 8000 rpm regardless of setting. Manufacturer: Metron Instrument Co., 432 Lincoln St., Denver 9, Colo.

For additional information circle MD 38 on Page 161

Two-Speed Timer



Providing for selection of either 6 or 60-minute adjustable timing intervals, Mark-Time two-speed timer can be used in ranges, electrical appliances and industrial equipment. Utilizing center-stud mounting, timer and its dial are secured to panel with single washer and nut. Unit measures 2 11/16 inches in diameter and 1⅜ inches in depth behind panel. Full 360-degree sweep of dial is employed for both 6 and 60-minute timing. Each dial is divided into six major divisions, numerals of which feature large first digit and small zero to indicate 1 minute on 6-minute operation and 10 minutes when on 60-minute cycle. Manufacturer: M. H. Rhodes Inc., 28 Bartholomew Ave., Hartford, Conn.

For additional information circle MD 39 on Page 161

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HELPFUL LITERATURE

FOR DESIGN EXECUTIVES

74. Fuel-Resistant O-Rings

Parker Appliance Co.—Bulletin 934 covers O-rings specially compounded for aircraft use in sealing fuel systems. Application of four fuel-resistant compound types is discussed, with tabulation of physical properties and percentage volume change under variety of conditions. Dimensions of O-ring sizes are listed; and molding of special diaphragms, gaskets and other sections is discussed.

75. Relays

Phillips Control Corp.—12-page illustrated catalog No. 7 lists line of relays suitable for electronic and industrial control, signal and traffic control, radio, communications and aircraft.

76. Air Filter

Dollinger Corp.—8-page illustrated bulletin describes Staynew model A-3 automatic self-cleaning type air filter. Designed for filtering large air volumes and heavy dust loads, unit utilizes filter elements consisting of two endless curtains carried on roller chains which are driven by sprockets keyed to shafts of curtain rollers.

77. Non-Rotating Air Motors

Bellows Co.—16-page illustrated bulletin BM20-R covers line of nonrotating, double-acting, reciprocating power units with built-in valve, valve operating controls and independent piston stroke speed controls. They are built with either mechanically or electrically operated valves for use in repetitive push, pull or lifting operations.

78. Hydraulic Equipment

Commercial Shearing & Stamping Co.—8-page illustrated "Oil Hydraulic Products" bulletin covers line of hydraulic valves, cylinders, pumps and motors and manually operated units. Types, capacities, controls and dimensions of various units are included.

79. Hand Pumps

Romec Pump Co.—4-page illustrated catalog No. 4-25 discusses Utility Master hand-operated vane type rotary pumps which deliver up to 10 gallons per minute. Pump operates in either direction of rotation and can be mounted in any position. Various accessories for special applications are covered.

80. Motor Control System

Brown-Brockmeyer Co.—2-page illustrated bulletin No. 860 describes "Dyna-Speed" electronic motor control system and presents data on performance, operation, applications and dimensions.

81. Air-Operated Devices

Mead Specialties Co.—48-page illustrated "1949 Industrial Air Power" catalog and enclosed price list cover line of air cylinders and air-operated devices for variety of industrial applications.

82. Hydraulic Control Valves

Hydraulic Equipment Co.—4-page illustrated file V 15-10149 is descriptive of Hydreco tank mounting V15 series control valves with capacities up to 5 gallons per minute. One to three plungers individually control one to three single or double-acting hydraulic cylinders and can be arranged to operate in any desired sequence in valve housing.

83. Cemented Carbide Tools

Kennametal Inc.—78-page illustrated catalog 49 and attached price discount sheet No. 49-A cover completely line of cemented carbide tools, their applications, specifications and characteristics.

84. Precision Valves

Hanna Engineering Works—16-page illustrated catalog No. 251 includes descriptions, specifications and features of foot operated, hand operated, Unitite Jr., speed control, solenoid, Mastair, pilot, and foot pilot air or oil-hydraulic control valves.

85. Carbon Products

United States Graphite Co.—64-page illustrated wire-bound catalog describes engineering use of Graphitar, carbon-graphite product, and lists physical data, chemical resistance and manufacturing limitations.

86. Sleeve-Bearings

Evans Bearing Div.—4-page illustrated bulletin entitled "Fusion Bonded Bearings" depicts how company can supply completely precision machined babbitt lined steel, cast iron or bronze-backed split or full round sleeve bearings to specifications.

87. Mercury Relays

Ebert Engineering & Mfg. Co.—4-page illustrated bulletin No. 48 concerns redesigned line of mercury plunger relays. Outline drawings and technical data are included.

88. Stainless Steel Tubing

Carpenter Steel Co., Alloy Tube Div.—92-page illustrated data book contains detailed engineering information on selection, fabrication and use of stainless steel tubing and pipe. Data on physical properties and corrosion and heat resistance provided by various types are listed. Book gives information on tolerances, sizes and shapes of stainless tubing and pipe produced by company.

89. Powder Metal Parts

United States Graphite Co.—264-page illustrated publication "Gramix—a Product of Powder Metallurgy" covers in detail typical parts and applications of powder metal parts. Design factors, general characteristics and production methods are covered and sizes, types and specifications of products are listed.

90. Alloy Castings

American Brake Shoe Co., Electro-Alloys Div.—6-page illustrated folder T-171 is entitled "Solving Corrosion Problems with Chemalloy High-Alloy Castings." Bulletin features two charts to aid in selection of proper alloy for various corrosive conditions. Various alloy types with composition and mechanical properties of each are detailed.

91. Thermocouples

Bristol Co.—56-page illustrated bulletin No. P1238 presents detailed information on thermocouples, protection tubes, insulators, extension wire and other pyrometer accessories. Tables of calibration data for commonly used base metal and rare metal thermocouples are included.

92. Bus Ducts

Westinghouse Electric Corp.—12-page illustrated booklet B-4271 explains uses of bus ducts in secondary power distribution systems. Publication illustrates four types of bus ducts available and tells where each type is applicable. Attention is given to construction and installation features.

93. Push-Pull Controls

Simmonds Products, Inc.—4-page illustrated folder "Simmonds Precision Built Push-Pull Controls" describes device for transmitting mechanical motion from convenient point of application to remote point of operation.

FOR MORE INFORMATION

on developments in "New Parts" and "Engineering Department" sections—or if "Helpful Literature" is desired—circle corresponding numbers on either card below.

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94. Light Metal Fabrication

Colgate Mfg. Corp.—20-page illustrated brochure is entitled "Points to Check in Selecting a Sheet Metal Fabricator Specializing in Aluminum, Magnesium and Stainless Steel." It explains ways in which organization functions: as contract manufacturer; as complete manufacturing department; and as integrated design, tooling, production, finishing, assembly and packaging service.

95. Metal Preservation

American Chemical Paint Co.—Seven folders describe metal preservation processes. They include Alodine for aluminum, Deoxidine metal rust remover, Duridine metal cleaner, Granodizing zinc phosphate coating for steel, Lithoform which makes paint stick to galvanized iron, Rodine for pickling and Thermoil-Granodine for protection against rust and wear.

96. Centrifugal Pumps

Ingersoll-Rand Co.—8-page illustrated publication form No. 7074-C contains description, dimensions and performance tabulation for close-coupled fractional horsepower Motorpumps, immersion type pumps, sidewall types and cradle mounted pumps.

97. Flexible Hose Products

American Ventilating Hose Co.—12-page illustrated catalog No. 30 contains general information and engineering data on lightweight strong flexible Flexaust spiral wire reinforced hose, Portovent ring reinforced retractable hose, and Bioflex nonreinforced collapsible hose.

98. Standard Slide Switches

Stackpole Carbon Co.—8-page illustrated engineering bulletin form RC 7C covers variety of slide switches for wide range of electrical equipment and appliances. Included are spring return, three-position, indent action, push type momentary contact, gang and other slide switches.

99. Low Temperature Alloys

Cerro de Pasco Copper Corp.—2-page form J2-11-48 presents physical data on standard Cerro-Alloys for low temperature application. Given also in both tabular and graphical form, are cumulative growth and shrinkage per inch compared to cold mold dimensions.

100. Gear Assemblies

Amgears, Inc. — Bulletin containing eight case histories taken from actual jobs covers in detail means of reducing gear costs or improvement of product using gear assemblies.

101. Forgings

Pittsburgh Forgings Co.—64-page booklet is pictorial review of step-by-step operations in forging of freight car, automotive, farm implement and miscellaneous products and parts. Space is devoted to engineering, quality control and operation control procedures practiced.

102. Expansion Joints

Chicago Metal Hose Corp.—8-page illustrated bulletin EJ-49 gives engineering and product information on Free-Flexing and Controlled-Flexing corrugated type expansion joints for pipe lines in copper and stainless steel construction.

103. Industrial Reducers & Thinners

Sherwin-Williams Co. — 10-page pamphlet "Industrial Reducers & Opex Thinners" discusses groups of industrial reducers, circumstances to be considered in selecting proper solvent and Opex lacquer thinners.

104. Timing Motors & Devices

Haydon Mfg. Co.—20-page illustrated catalog No. 321 presents details of line of synchronous timing motors, chart drives, timing and clock movements. Included also are battery charger timers, defroster timers and elapsed time indicators.

105. Electronic Control Device

Reliance Electric & Engineering Co.—2-page illustrated bulletin K-2051 describes electronic VSP camber control device designed to provide automatic guiding and positioning of sheet materials in high-speed web and strip processing.

106. Fastenings Catalog

H. M. Harper Co.—32-page illustrated 1948 catalog lists more than 5000 standard nonferrous and stainless steel fastenings and gives dimensions, packaging data and prices of each. For instant reference, material is sectionalized into main divisions of bolts, nuts, screws, washers, rivets and accessories.

107. Electric Cable Vulcanizers

Mines Equipment Co.—16-page illustrated bulletin RV106, second edition, describes line of electric cable vulcanizers and offers suggestions on use of vulcanizing compounds. It also lists variety of molds for popular cord and cable diameters.

108. Forging Rods & Shapes

Titan Metal Mfg. Co.—4-page illustrated folder is entitled "Titan Forging Rods and Shapes." In it are set forth chemical composition of ten brass and bronze alloys used, as well as average physical properties of forgings made from them. Typical brass forgings are depicted.

109. Photoelectric Cells

Vickers Electric Div.—12-page illustrated catalog VC-4000 depicts various self-generating photoelectric cell applications and lists design specifications. Ordering information is included also.

110. Tubular Rheostats

James G. Biddle Co.—12-page illustrated bulletin No. 41-33 describes various styles of standard, screw drive, double, graded, switchboard, metal caged and non-inductive rheostats. Diagrams and examples of various applications of rheostats are shown.

111. Hardsurfacing Electrodes.

Lincoln Electric Co.—Illustrated folder "Lincoln Hardsurfacing Guide" charts line of hardsurfacing electrodes as to resistance to abrasion and to impact, lists applications, and explains procedures for use.

112. Precision Parts

Kohler Co.—20-page illustrated form A144 lists various precision parts for aircraft, industrial and automotive use including check valves, pressure relief valves, restrictors, jet engine controls and shut off valves.

113. Ball Bearings

Marlin-Rockwell Corp.—4-page form 1528-1 presents Synthe-Seal standard-dimension ball bearings with removable synthetic rubber seal for keeping out dirt, grit and moisture. Advantages, types, specifications and applications are listed.

114. Electronic Alloys

International Nickel Co.—26-page booklet "Inco Nickel Alloys for Electronic Uses" indicates electrical and electronic properties of 18 high nickel alloys. It cites typical uses of these materials and various forms in which they are available.

115. Die & Wear Parts

Metal Carbides Corp.—36-page catalog No. 48-WP contains full particulars and prices on Talide-tipped centerless grinder blades, sheet metal draw dies, wire and tube dies, bolt dies, drill jig bushings, gages and solid carbide bars and tubes and wear strips. Engineering and design data are included.

116. Reproducing Equipment

Ozalid Co.—4-page form illustrates and describes Ozalid machines for reproducing lines or images in different colors on paper, cloth, foil or film. Principle of operation is explained, correct machine for individual need is covered, and machine specifications and short cuts in usage detailed.

117 Finishes

New Wrinkle, Inc.—8-page booklet entitled "Making Money with New Wrinkles in Finishing" describes organic finish suitable for application to practically any surface and which develops textured surface during drying phase.

118. Pneumatic Cylinders

James L. Entwistle Co.—12-page illustrated catalog No. 20A contains dimensions, ordering information, prices and parts list for nonrotating noncushioned pneumatic cylinders having bore sizes from 1½ to 10 inches in diameter and suitable for operating pressures up to 110 pounds per square inch.

119. Permanent Magnets

General Electric Co.—28-page illustrated manual "Permanent Magnet Catalog" presents information on cast and sintered Alnico permanent magnets as well as special magnetic alloys such as Cunico, Cunife, Silmanal and Vectolite. In addition to stocked magnets, dies available for sintered Alnico-2 cylinders and hollow cylinders are listed.

120. Stampings & Assemblies

Reynolds Metals Co.—2-color brochure explains many inherent advantages of using aluminum stampings and assemblies for washing machines, automatic bottle dispensers and related products. Manufacturing facilities and types of finishes available are listed also.

M. D. Numbers

1	21	41	61	81	101
2	22	42	62	82	102
3	23	43	63	83	103
4	24	44	64	84	104
5	25	45	65	85	105
6	26	46	66	86	106
7	27	47	67	87	107
8	28	48	68	88	108
9	29	49	69	89	109
10	30	50	70	90	110
11	31	51	71	91	111
12	32	52	72	92	112
13	33	53	73	93	113
14	34	54	74	94	114
15	35	55	75	95	115
16	36	56	76	96	116
17	37	57	77	97	117
18	38	58	78	98	118
19	39	59	79	99	119
20	40	60	80	100	120

MACHINE DESIGN **8-49**

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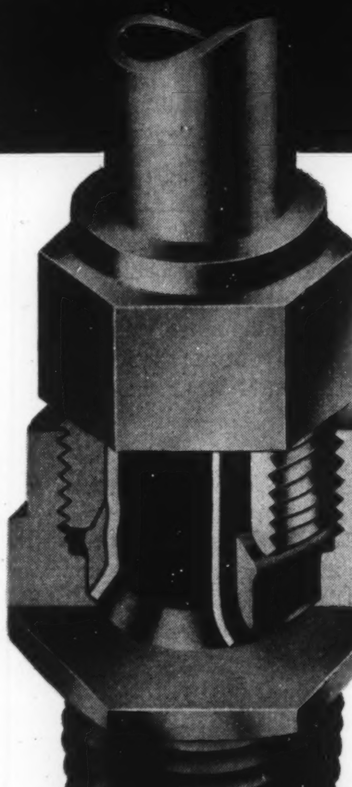
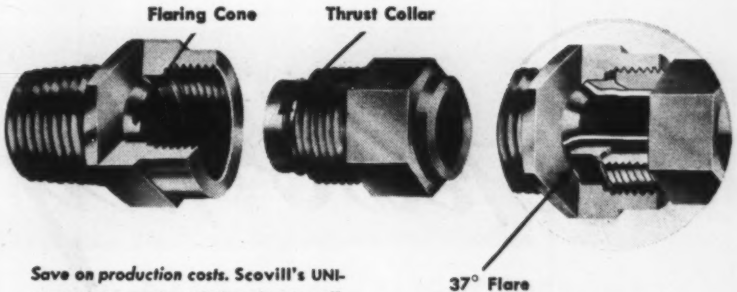
Is Tube Fitting No. 1





Save on production costs. **Scovill's UNIFLARE is two-piece fitting that is *self-flaring*. No preliminary flaring operation—no flaring tools needed—no tube cracking that sometimes accompanies flaring. And you can use lighter, less costly tubing.**

Assure tighter seal. **Scovill's UNIFLARE makes the recommended 37 degree flare without weakening the tube. Special brass alloy permits more tightening.**

Provide greater strength. **Scovill's UNIFLARE has triple the strength of a compression fitting. Exhaustive pressure tests prove that the tube will burst (but not at the joint) before the UNIFLARE fitting will leak. The assembly illustrated above was subjected to such a test.**

Allow for frequent disassembly. **Scovill's UNIFLARE can be taken apart and reassembled many times without weakening the seal.**

UNIFLARE is available in a complete range of sizes for tubing 1/8 in. through 1 in. O. D. and in all standard shapes. Fully tested and approved by the Underwriters' Laboratories, Inc.

You can safely specify UNIFLARE for refrigeration, etc. The inverted flare and taper of nut thread toward wrench end help keep out condensate.

HOW DOES IT WORK?

One turn of the nut shears off the thrust collar, clamping it onto the tube; further tightening forces the tube over the flaring cone and makes the seal. No flaring tools needed . . . no separate flaring operation . . . no cracked tubing to worry about.

Investigate UNIFLARE for oil, air, water or hydraulic lines. Write on company letterhead for a working sample. Address Screw Machine Products Division, SCOVILL MANUFACTURING COMPANY, 50 Mill Street, Waterbury 91, Conn.

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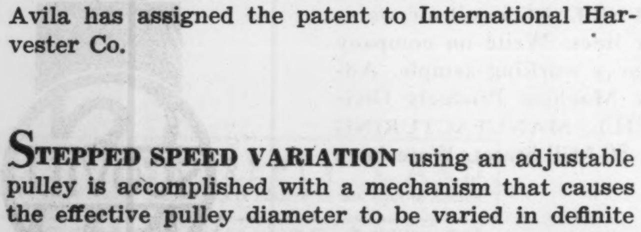
SCOVILL

Uniflare —The Complete, Self-flaring Tube Fitting

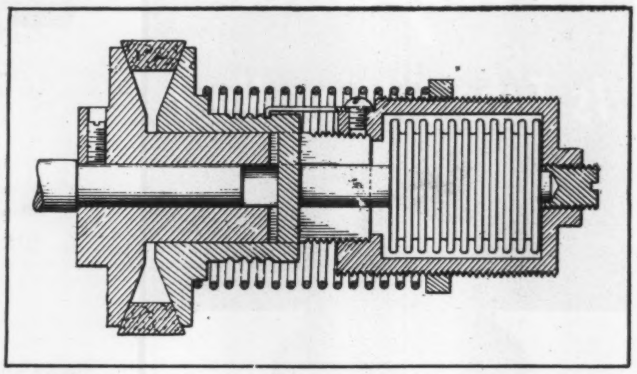
Noteworthy Patents

HELICALLY-WOUND STRAIN GAGES offer a solution to the problem of measuring small tensile and compressive stresses. Eliminating the difficulty of securing the conventional flat strain gage to a metallic strip small enough to measure low stresses of one to 100 psi, the new gage uses wire wound on a circular rod or tube. The wire is insulated from the rod and cemented to it. Tension applied to the rod increases its length but decreases its periphery, producing compression and decreased electrical resistance in the wire. Compression of the rod results in tension in the wire and increased electrical resistance. Patent 2,467,752 assigned to the Foxboro Co. by Wilfred H. Howe.

REQUIRING NO LUBRICATION, the axle suspension system covered in patent 2,467,721 makes use of rubber in torsion and compression to obtain the desired spring action. Suspension arms are secured to the frame and axle through rubber bushings. Vertical deflection of the axle is resisted by these rubber bushings, and as vertical deflection occurs, horizontal movement of the suspension arm pivot pins results in the compression of rubber blocks or pillows and consequent damping action. Flexibility of the system can be varied at the time of installation by variation in the torsion and compression under which the bushings and blocks are assembled. Frank W. Avila has assigned the patent to International Harvester Co.



STEPPED SPEED VARIATION using an adjustable pulley is accomplished with a mechanism that causes the effective pulley diameter to be varied in definite steps. Two halves of the pulley are telescopically mounted on the motor shaft and urged together by a bellows thermostat, but are prevented from relative axial movement by the engagement of a spring finger in peripheral grooves in one of the pulley hubs. Expansion of the bellows due to temperature rise drives the two pulley sections closer together whenever the axial pressure is sufficient to force the spring finger over into the next groove, causing the belt to run at a larger pitch diameter and greater speed. Axial force is spring adjusted to control the temperatures at which the speed changes take place. Originally applied to the blower on a warm air furnace, the device is described in patent 2,459,377 which has been granted to William W. Hallinan.



AUTOMATIC CLUTCHING for connecting a driven to a driving member after the latter has come up to operating speed is described in patent 2,458,389. Centrifugally-controlled planetary gearing is employed so that when a drive pulley is started, a flyball arm is held in its retracted position by a spring and the planetary pinion rotates around a sun gear on the driven shaft. When the driving member is up to speed, the flyball governor arm engages a lever on the planetary gear cage, locking planetary and sun gears together and causing the driven shaft to be turned. The device, patented by Henry E. Korum and assigned to Deere & Co., was first used to transmit power to the feeding mechanism of crop treating machines, such as hammer mills, corn shellers, etc., where it is necessary for the cutter to be at operating speed before starting to feed in the material being processed. The device will also disconnect the driven, or feeder shaft if the driving, or cutter shaft slows down, thereby preventing excess loading and jamming of the equipment.

Genuine ALEMITE LUBRICATION FITTINGS

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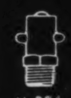
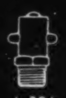
Simplify ORDERING, INSPECTION and INVENTORY CONTROL. Specify Alemite part numbers on your blueprints.


M-336
Non-Corrosive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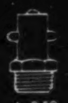
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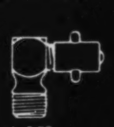
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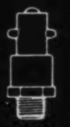
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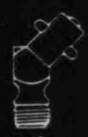
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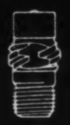
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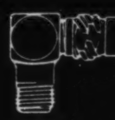
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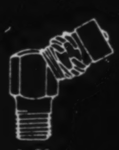
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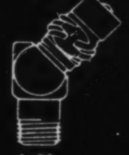
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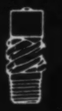
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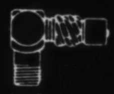
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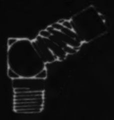
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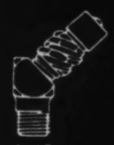
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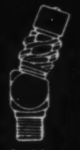
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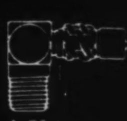
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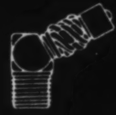
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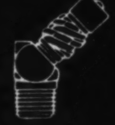
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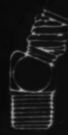
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ALEMITE

Modern Lubrication Methods That Cut Production Costs

Useful Information to Help You Select and Specify the Right Alemite Fitting for Every Bearing

PIN TYPE FITTINGS

The original lubrication fitting developed by Alemite. Named after the positive locking of the Pin Type Coupling on the cross pin of the fitting.

PART NO.	THREAD SIZE	FITTING ANGLE	LENGTH OVERALL
A-336	⅛″ P.T.	Straight	1″
M-336	⅛″ P.T.	Straight	1″
A-359	¼″ P.T.	Straight	1 3/32″
A-358	⅛″ P.T.	90°	1 1/16″
A-850	⅛″ P.T.	Straight	1 31/64″
A-684	⅛″ P.T.	45°	1 9/16″

MOGUL DOT FITTINGS

Similar to the Dot Fittings above, except larger and more rugged to withstand hard industrial use on heavy machinery.

PART NO.	THREAD SIZE	FITTING ANGLE	LENGTH OVERALL
1489	¼″ P.T.	Straight	1 7/16″
1490	¼″ P.T.	90°	1 11/32″
1491	¼″ P.T.	60°	1 21/32″
1492	¼″ P.T.	45°	2″

STANDARD DOT FITTINGS

Commonly used on heavy duty machinery such as contractors' equipment, wood working machinery, canning machinery, etc. Gun coupling screws on to the fitting thread, making a positive seal.

PART NO.	THREAD SIZE	FITTING ANGLE	LENGTH OVERALL
1461	⅛″ P.T.	Straight	1 15/64″
1463	⅛″ P.T.	90°	1″
1464	⅛″ P.T.	60°	1 15/32″
1465	⅛″ P.T.	45°	1 21/32″
1466	⅛″ P.T.	20°	1 13/16″
1475	¼″ P.T.	90°	1 3/16″
1476	¼″ P.T.	60°	1 7/16″
1477	¼″ P.T.	45°	1 21/32″
1478	¼″ P.T.	20°	1 ⅞″

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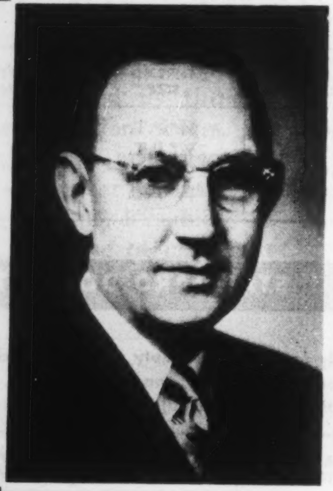
Men OF MACHINES

Peter P. Ruppe

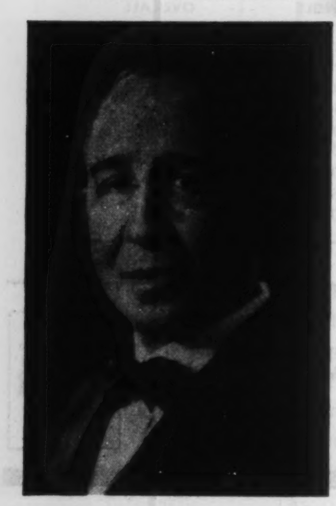
Peter P. Ruppe has been appointed general manager of Hapman Conveyors Inc., Detroit. Mr. Ruppe received his mechanical engineering degree from Michigan State College and has been employed as design engineer with Bohn Aluminum & Brass Co., Lansing Engineering Co., and Briggs Manufacturing Co. He left Briggs to become project engineer on process machinery with the United States Rubber Co. Prior to his present appointment he was chief engineer of Hapman Conveyors.



Marvin W. Smith

Marvin W. Smith, executive vice president of Baldwin Locomotive Works, Philadelphia, was recently elected president and chief executive officer of the company. He came to Baldwin from Westinghouse Electric Corp., where he served as vice president in charge of engineering and research. He came to that firm shortly after graduation from Texas A and M in 1915. As a student engineer with Westinghouse he was selected by the late Benjamin G. Lamme for a special course in design engineering. He was appointed division engineer in 1930 and was in charge of the design of many large generators, such as those for Hoover and Norris Dams. In 1936 Mr. Smith was named manager of engineering and was elected vice president in charge of engineering and research at Westinghouse in 1939.

Allen H. Candee



The American Gear Manufacturers Association announces that the 1949 recipient of the Connell Award is **Allan H. Candee,** mechanical engineer, The Gleason Works, Rochester, N. Y. Mr. Candee obtained his degree in mechanical engineering from Cornell University and has been associated with Allis-Chalmers Mfg. Co., Johns-Manville Co., and the Falk Corp. He has been with The Gleason Works since 1923. Mr. Candee holds more than thirty patents on methods, machines and tools for generating gears, and is the author of numerous engineering society papers, magazine articles and other material on gearing. He is also a member of the American Society of Mechanical Engineers. He has served AGMA in various capacities since 1929, as a member of the executive committee for two terms and as chairman of a number of technical committees. The Edward P. Connell Award is made to Mr. Candee in recognition of his many valuable contributions to the gearing industry's technical knowledge and literature over the past three decades.

W. R. Leopold is now design engineer, Special Products Div., M. W. Kellogg Co., Jersey City, N. J. Mr. Leopold received his mechanical engi-

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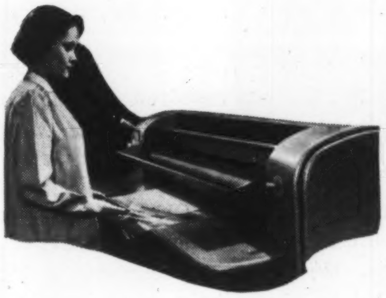

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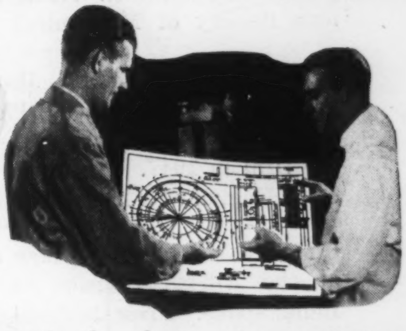

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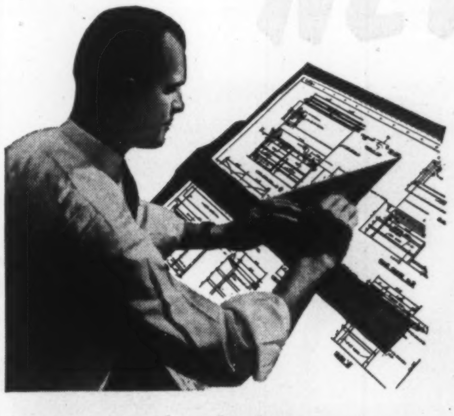

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neering degree from Illinois Institute of Technology and his master's degree from Stevens Institute of Technology. Prior to joining the Kellogg company he was with Wright Aeronautical Corp. where he served as test engineer, stress analyst and design engineer, gas turbine division. He is a member of the American Society of Mechanical Engineers.

◆

Appointment of **C. E. Hammond** as quality engineer of the Shippensburg, Pa. division of SKF Industries Inc., has been announced. Mr. Hammond joined the firm in 1947. Previously he had been with Fairchild Engine and Aircraft Corp., Hagerstown, Md.

◆

Melvin N. Osborn is now senior layout draftsman at the Allison Division of General Motors Corp., Indianapolis. Prior to this post he was project engineer at Wayne Pump Co., Fort Wayne, Ind.

◆

Fairbanks, Morse & Co., Beloit, Wis. announces the appointment of **Ervin L. Dahlund** as chief engineer of the diesel engineering department.

◆

Lee Douglas has been named chief engineer of Piasecki Helicopter Corp., Morton, Pa. Formerly he was chief engineer and general manager of Kellett Aircraft Corp., North Wales, Pa. He joined Kellett in 1944 and prior to that time was associated with the Brewster Aeronautical Corp., Bell Aircraft Corp., and Seversky Aircraft Corp.

◆

Recent election of **S. Floyd Stewart** as president of Leece-Neville Co., Cleveland, has been announced. He joined Leece-Neville in 1936 as a research engineer and has been executive vice president of the company since August, 1946.

◆

Otto C. Reichel is now a designer for the Caterpillar Tractor Co., East Peoria, Ill. He formerly held a similar position with R. G. LeTourneau Inc., Peoria.

◆

James W. Mohr, Sr. is now research and development engineer with Kiekhaefer Aeromarine Motors Inc., Fond du Lac, Wis.

◆

Cleveland Pneumatic Tool Co., Cleveland, has announced the appointment of **Elmer W. Krueger** as operations manager. He came to Pneumatic in 1922, and after several years as designer in the engineering department, was appointed assistant chief engineer of the automotive and aircraft division.

◆

Bound Brook Oil-Less Bearing Co., Bound Brook, N. J., announces the election of **W. R. Toeplitz** as vice president in charge of engineering research.

◆

Appointment of **Harry R. Reynolds** as consulting engineer and **Howell L. Potter** as chief engineer has been announced by Fafnir Bearing Co., New Britain, Conn. Mr. Reynolds has been with Fafnir since the company's formation in 1911. Mr. Potter has been with the company for 15 years, serving as assistant chief engineer in recent years.

HERE'S MOTOR EXPERIENCE THAT CAN BE *yours*

- A high percentage of all Peerless Motors are manufactured to meet the specific operating requirements of the equipment with which they are to be used. Answering these motor problems has given Peerless engineers an experience that can be yours when you call Peerless for advice on motor applications.

You will save time, energy and money by turning your motor problems over to Peerless. Call on us by telegram or telephone. Increased engineering and production facilities can be put to work for you promptly.

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Single Phase • Polyphase • Direct Current Motors

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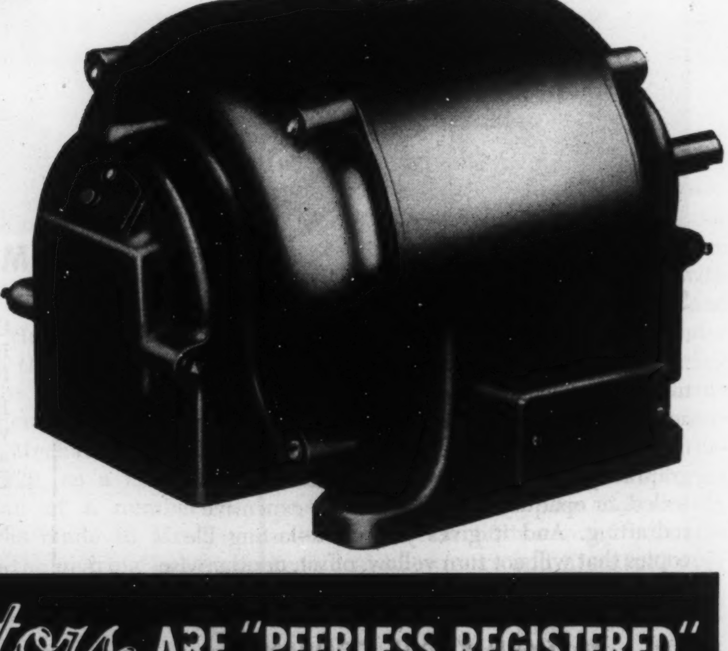

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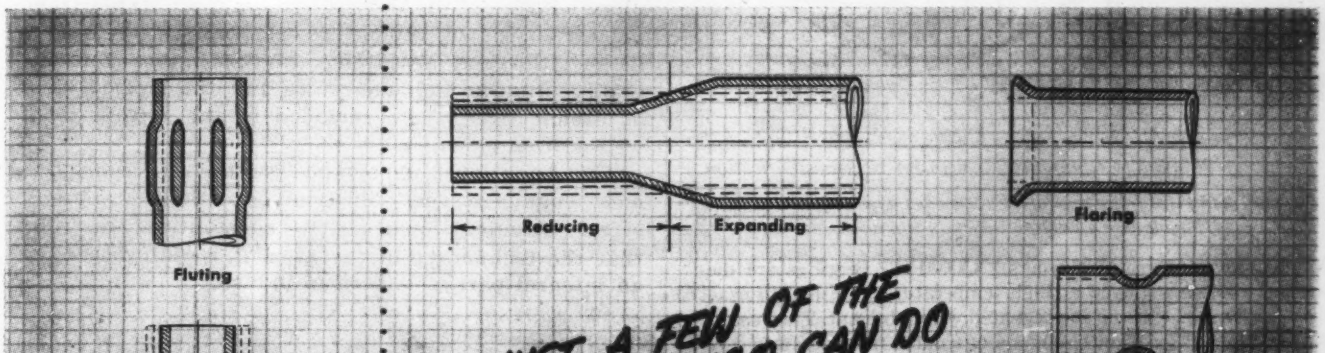
INCREASE YOUR PROFIT MARGIN WITH OSTUCO TUBING

The best way to increase your profit margin is to cut costs. And on a surprisingly wide range of products from airplanes to fountain pens, manufacturers are cutting production costs and, at the same time, improving quality, with Ostuco tubing. Ostuco can pass along important economies in cutting, bending, swaging, tapering, threading, expanding and many other operations because of specialization in and complete modern facilities for the forging and fabricating of tubing. Investigate the profit possibilities in using Ostuco tubing for *your* product . . . our prompt deliveries will enable you to operate with lower inventories. Write direct or to our nearest Sales Office for new free booklet "Fabricating and Forging Steel Tubing."


Fluting
Reducing
Expanding
Flaring
Depressed Beading
JUST A FEW OF THE THINGS OSTUCO CAN DO WITH TUBING
Reducing
Nosing
Contour Cutting
Internal Upsetting
OSTUCO
OSTUCO TUBING

THE OHIO SEAMLESS TUBE COMPANY
Plant and General Offices: Shelby 5, Ohio

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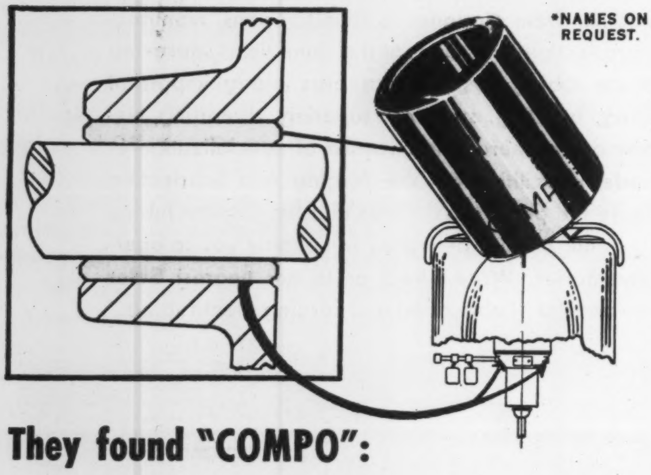
CANADIAN REPRESENTATIVE: Railway & Power Corp., Ltd., NEW GLASGOW, MONTREAL, NORANDA, NORTH BAY, TORONTO, HAMILTON, WINDSOR, WINNIPEG, EDMONTON, VANCOUVER

"COMPO"
OIL-RETAINING
POROUS BRONZE BEARINGS

Why did 3 large Automobile Manufacturers* Switch to "COMPO" FOR CLUTCH RELEASE SHAFT BEARINGS?

*NAMES ON REQUEST.



They found "COMPO":

1. *Saved the cost of two grease fittings, the time for drilling and tapping, and eliminated the need for frequent lubrication.*
2. *Simplified design problems, speeded assembly and resulted in trouble-free operation and minimum maintenance.*

Made from pure metal powders, "COMPO" Bearings are die-formed to shape, alloyed at high temperatures, finished to exact dimensions, and vacuum-impregnated with lubricant. They can be depended upon for countless hours of trouble-free operating service. Self-lubricating qualities make them ideal for use in inaccessible spots. The lubricant is sealed in, free from dirt, and an even lubricating film is always present.

"COMPO," and other Bound Brook Bearings, are showing savings like these not only in other automotive applications, but wherever moving parts must run true, smooth and free from friction. Thousands of sizes can be made from existing dies; hundreds of sizes in stock for prompt shipment.

Whatever may be your bearing requirements, consult a Bound Brook engineer. Mail the coupon below today. *We've saved time and costs for others. We can do the same for you.*

Many types of structural parts can be made of "COMPO." On large volume requirements, their use effects great savings by eliminating machining normally needed to hold required tolerances.

BOUND BROOK OIL-LESS BEARING COMPANY

BEARINGS • BUSHINGS — WASHERS • PARTS

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Bound Brook Oil-Less Bearing Co.
Bound Brook, N. J.
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☐ I would like to talk to one of your engineers about______

☐ Please send me a copy of your "COMPO" Bearing Stock List.

Name______ Title______

Company______

Street______ City______ State______

The Engineer's Library

Constructive Uses of Atomic Energy

Edited by S. C. Rothmann; published by Harper & Brothers, New York; 258 *pages,* 6 *by* 9 *inches, clothbound, available through* MACHINE DESIGN $3.00 *postpaid.*

Atom has become the byword to a new world which as yet is somewhat remote. Scientists have had difficulty in transmitting what they know to engineers not conversant with the various aspects of this new source of power. This book is a compilation of articles submitted by the leaders in atomic research; it is a view of atomic energy from "the outside looking in." The haze is lifted to reveal tremendous potentialities.

Arthur H. Compton, L. W. Chubb, Samuel K. Allison, M. Blau, H. Etherington and many other describe specifically and clearly the atom in every phase. Physical properties, radioactivity application, industrial use of atomic power, radioactive tracers in metallurgical research, atomic engines for aircraft, ceramics and nucleonics and the medical uses of atomic energy are included in the repertoire of well-written papers.

This book is of importance for the interested laymen, engineers and industrial executives because it offers abundant evidence to substantiate the fact that the technology of the atom is rapidly becoming an integral part of American industry.

□ □ □

Engineering Optics

By K. J. Habell and Arthur Cox, published by Pitman Publishing Corp., New York, N. Y.; 410 *pages,* 5½ *by* 9 *inches, clothbound; available through* MACHINE DESIGN, $7.50 postpaid.

Demand for precision as well as cheap and rapid production has led to the adoption of optical methods in many branches of engineering today. Such methods can be used in a variety of ways, from tool inspection on the one hand, where meticulous accuracy is of paramount importance, to certain types of final inspection on mass-produced articles where a reasonable degree of accuracy has to be combined with speedy operation. The fact that, when properly used, they may lead to considerable economy in time and labor means that it is of importance to know what can and what cannot be accomplished by optical means, and to realize the basic principles to be observed in the design and use of optical equipment.

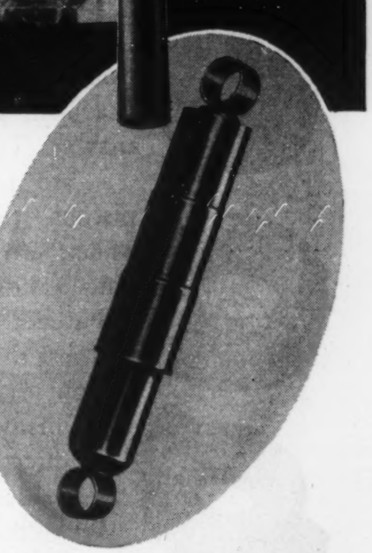
In this treatise the authors make a critical survey of the most important optical methods and instruments that are applicable to engineering practice. Two theoretical chapters on the properties of ideal systems are included, and other chapters deal with

Houdaille-Hershey makes better shock absorbers *at lower cost* with J&L free-machining ELECTRICWELD STEEL TUBING

J&L STEEL

(*Above*) Multiple spindle broaching machine at the Houde Engineering Division of Houdaille-Hershey Corporation that machines the inside diameter of J&L ELECTRICWELD Tubing to 1/1000″ tolerance.

(*Left*) Aeroplane-type shock absorbers on the production line at the Houde Engineering Division, Houdaille-Hershey Corporation, Buffalo, N. Y.



When production runs into thousands of units daily, every possible saving in material and labor costs in each shock absorber is vital to efficient manufacturing. Houdaille-Hershey Corporation, Buffalo, New York, reduced manufacturing costs when it changed from more expensive cold-drawn tubing to J&L *free-machining* ELECTRICWELD Tubing for the main cylinder of precision-built hydraulic shock absorbers.

This special J&L tubing is made from *resulphurized, open-hearth steel.* The resulphurizing imparts the desired free-machining quality required by Houdaille-Hershey for broaching the interior surface of the cylinders with uniform precision to a tolerance of 1/1000 of an inch.

Because J&L controls every step in the manufacture of ELECTRICWELD Tubing from raw materials to finished product, it can give you the exact grade of steel you need to help you make a better product, faster, and at a lower cost.

If you use tubing in the manufacture of your product investigate J&L ELECTRICWELD Tubing. Write today for your copy of our new booklet: "J&L ELECTRICWELD TUBING *for more strength with less weight.*"

Jones & Laughlin Steel Corporation
410 Jones & Laughlin Building
Pittsburgh 19, Pa.

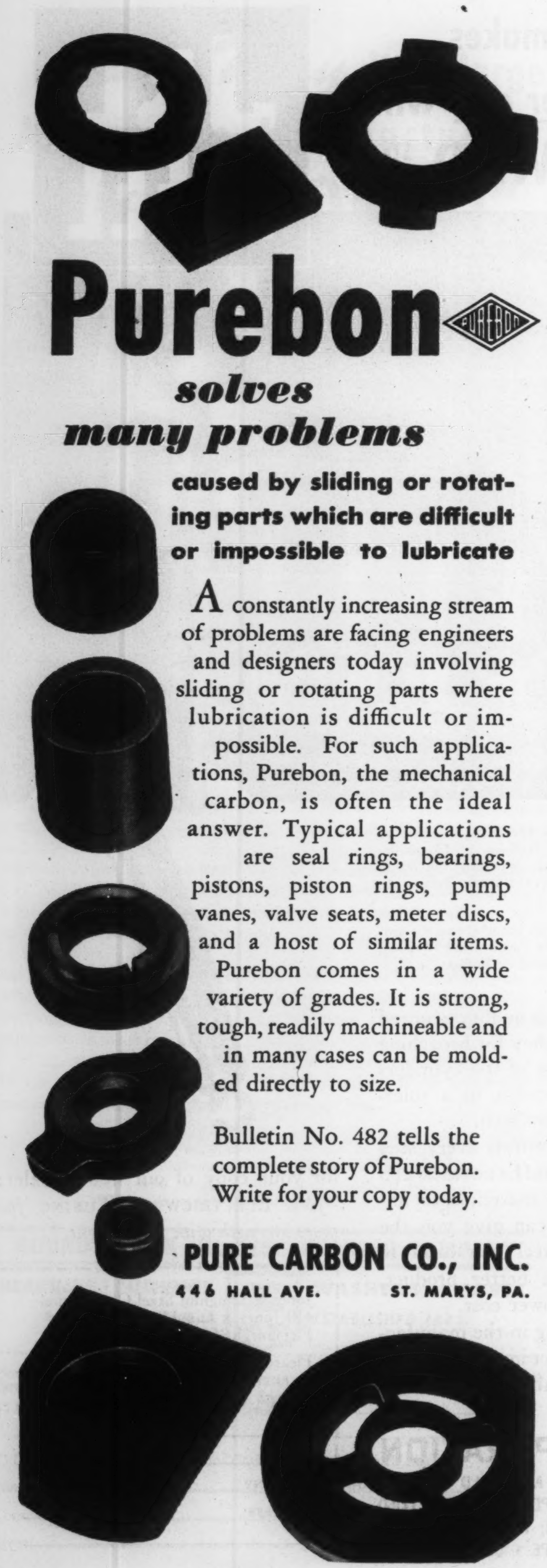
Please send me your booklet: "J&L ELECTRICWELD TUBING *for more strength with less weight.*"

NAME____________________
TITLE____________________
COMPANY__________________
ADDRESS__________________

JONES & LAUGHLIN STEEL CORPORATION

From its own raw materials, J&L manufactures a full line of carbon steel products, as well as certain products in OTISCOLOY *and* JALLOY *(hi-tensile steels).*

PRINCIPAL PRODUCTS: HOT ROLLED AND COLD FINISHED BARS AND SHAPES • STRUCTURAL SHAPES • HOT AND COLD ROLLED STRIP AND SHEETS • TUBULAR, WIRE AND TIN MILL PRODUCTS • "PRECISIONBILT" WIRE ROPE • COAL CHEMICALS



Purebon

solves many problems

caused by sliding or rotating parts which are difficult or impossible to lubricate

A constantly increasing stream of problems are facing engineers and designers today involving sliding or rotating parts where lubrication is difficult or impossible. For such applications, Purebon, the mechanical carbon, is often the ideal answer. Typical applications are seal rings, bearings, pistons, piston rings, pump vanes, valve seats, meter discs, and a host of similar items. Purebon comes in a wide variety of grades. It is strong, tough, readily machineable and in many cases can be molded directly to size.

Bulletin No. 482 tells the complete story of Purebon. Write for your copy today.

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microscopes, telescopes and other optical instruments, with the effects of light and illumination and with the methods of optical projection.

Intended primarily for the engineers using optical equipment, the book is richly illustrated with comprehensive diagrams and drawings and contains two dozen useful tables.

□ □ □

Descriptive Geometry

By B. Leighton Wellman, professor of mechanical engineering Worcester Polytechnic Institute; published by McGraw-Hill Book Co. Inc., New York; 508 pages, 6 by 9 inches, clothbound; available through MACHINE DESIGN, *$4.00 postpaid.*

Traditionally, descriptive geometry has been taught as a course in visualization; the unimaginative student has been foredoomed to failure. This book, written for the student, engineer and industrial draftsman, places the emphasis on logic, not imagination.

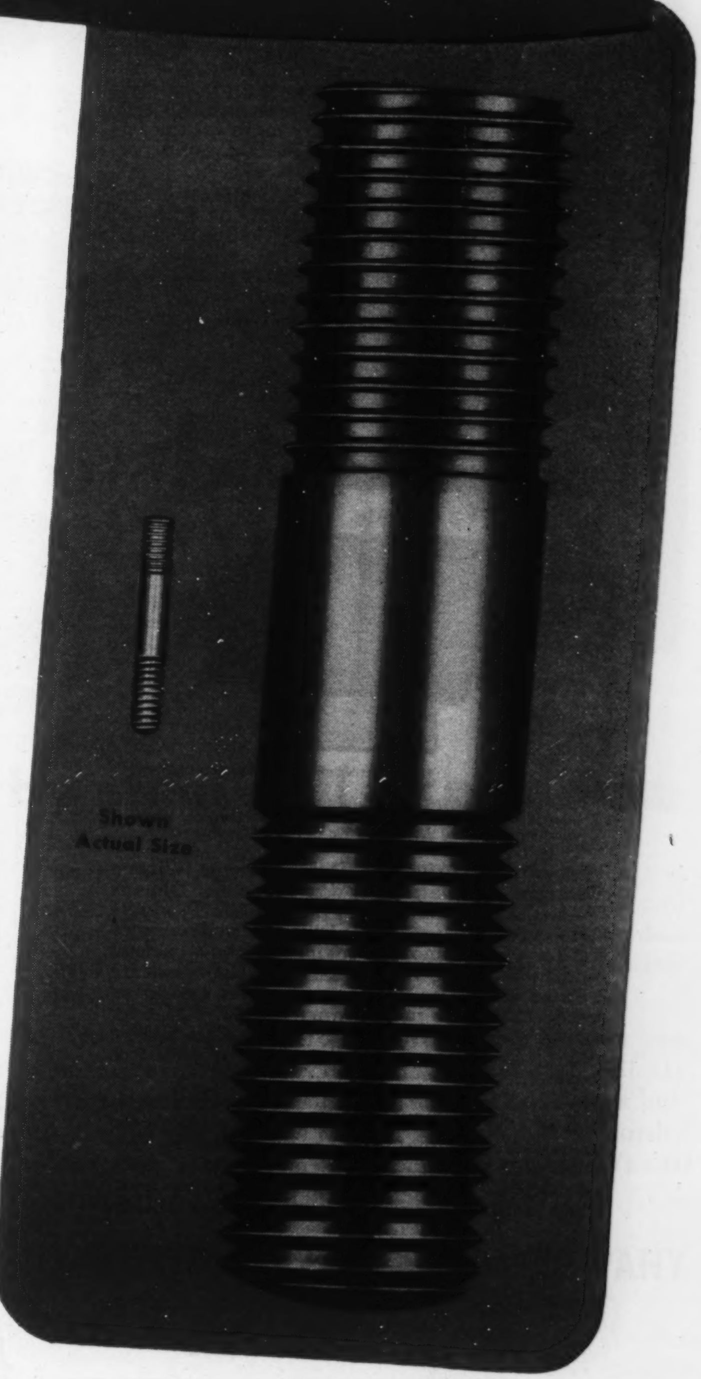
In topics and sequence this book follows closely the standard pattern of descriptive geometry texts except that the discussions are somewhat expanded to provide greater clarity. Practical applications have been emphasized, especially with respect to surfaces, their representation, intersections and development. Double-curved surfaces, important in ship, automobile and aircraft construction, are given more than usual space. The principle of the cone-locus is thoroughly explained. Convolute surface, adaptable in the design of surfaces, is emphasized. Cardinal principles are stated in the form of rules to provide review in as few words as possible.

Excellently presented with an abundance of graphical work to support discussions and with sufficient problem study to facilitate understanding, this text simplifies the approach to the all-important subject, descriptive geometry, and should, by stressing logical reasoning, assist in the development of that visualizing power necessary to all in the engineering field.

Society of Motion Picture Engineers has prepared a 129-page booklet consisting of papers presented at the symposium on high speed photography during the October 1948 convention. Specific topics discussed include electrical flash photography and a new high-speed stroboscope, lamps and motion picture equipment for high-speed photography, methods of analyzing high-speed photographs, and the uses of high-speed photography in the armed services, automotive and other industries and research. Entitled *High-Speed Photography,* the booklet may be obtained from the Society of Motion Picture Engineers, 342 Madison Ave., New York 17, N. Y., for $1.50.

American-British-Canadian Unified Screw Threads as applied to fasteners such as bolts, screws, and nuts is the subject of a book published by the Industrial Fasteners Institute. *Proceedings of Fastener Manu-*

They're both LOK·THRED


Shown Actual Size

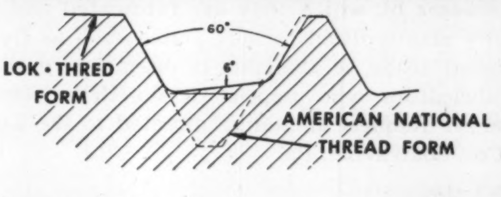
NOW . . . get Lok-Thred's greater strength . . more positive locking action . . in *any* size stud, bolt or screw

Are you making full use of LOK-THRED'S proved advantages—and its availability in any size or type of threaded fastener?

The revolutionary LOK-THRED design locks securely and becomes tighter in service . . . has much higher fatigue limits and is stronger in both tension and torsion than ordinary American National Threads...does not require selective fits:

These and other LOK-THRED features may offer important application advantages in your products. For full information, write for LOK-THRED booklet, today.

SEE THE DIFFERENCE!


60°
6°
LOK·THRED FORM
AMERICAN NATIONAL THREAD FORM

Note Lok-Thred's larger cross section . . . and flat root surface instead of a relatively sharp "V" . . . as compared to the American National Thread form. Here's the secret of Lok-Thred's greater strength.

1949 NATIONAL AIR RACES
AMERICA'S CLASSIC OF THE AIR
SEPT. 3-4-5
CLEVELAND

National
HEADED AND THREADED
PRODUCTS

THE NATIONAL SCREW & MFG. CO.
Cleveland 4, Ohio

Pacific Coast: National Screw & Mfg. Co. of Cal.
3423 So. Garfield Ave., Los Angeles 22, Cal.

DC DOW CORNING SILICONES Silicone News

Silicones Pay Off In a Buyer's Market

Your customers are demanding more for their money. Offer them better performance, longer life, greater reliability or reduced maintenance costs and they'll listen. Design all four of those basic sales appeals into your product and they'll buy. You can do that in many cases by taking advantage of the exceptional stability of Dow Corning Silicones.

For example, you can give your customers permanent lubrication by using DC 44 Silicone Grease. DC 200 Silicone Fluids enable you to design more compact hydraulic systems or make wider use of viscous damping. You can increase the power per pound ratio in electric machines by 50 to 100 per cent and you can increase the life of electrical equipment by a factor of 10 through use of Dow Corning Silicone—Class "H"—Electrical Insulation.

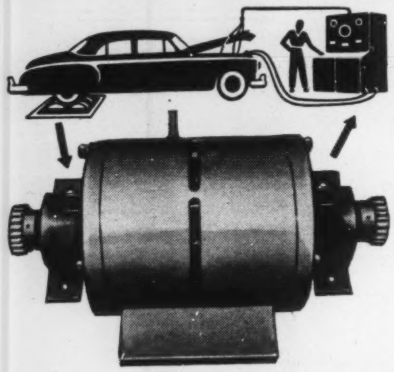


PHOTO COURTESY THE ELECTRIC PRODUCTS COMPANY

DC Silicone Electrical Insulation and DC 44 Silicone Grease improve the performance, cut maintenance and increase the life of E. P. Electric Chassis Dynamometers.

Typical application for Dow Corning Silicone Electrical Insulation is the Electric Chassis Dynamometer made by The Electric Products Company of Cleveland. Complete performance testing of automobile engines without actual road tests makes it necessary for the armature coils to absorb so much energy that operating temperatures are in the range of 400° F. Under such severe conditions, only Silicone Insulation and DC 44 Grease give long and trouble-free service.

Among many other applications, Silicone Insulation is used in building compact, high powered solenoids; portable welding transformers; bus generators and industrial motors. For more information about Dow Corning Silicone Electrical Insulation, write for pamphlet No. G11B8.

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Dow Corning
FIRST IN SILICONES

facturers' Symopsium is a 100-page book containing thirteen papers giving the background of international agreement, description and analysis of the new standard, and discussion of its effect on fastener manufacture. The book is available from the Industrial Fasteners Institute, 1550 Hanna Building, Cleveland, Ohio, for $1.50.

Manufacturers' Publications

Comprised entirely of papers submitted in the Award Program, *Design for Welding* presents solutions of individual welding problems which, although not intended to be authorative or exhaustive studies, present practical approaches capable of lending themselves to other design applications. Replete with diagrams, tables and discussions, the book should serve as a good reference for those whose design work calls for welding or whose design may profit by use of welding. The 1020-page book can be purchased from The James F. Lincoln Arc Welding Foundation, Cleveland 1, Ohio, for $2.00 in the U.S.A. and $2.50 elsewhere.

Intended primarily for use by design engineers and others of the electrical industry concerned with the application and use of electrical steel sheets, in coils and cut lengths, for rotating machines, transformers and other forms of electrical devices requiring laminated core materials, a 180-page booklet, *U. S. S. Electrical Steel Sheets,* can be obtained by writing on company letterhead to the Carnegie-Illinois Steel Corp., Pittsburgh, Pa.

Steel Plates and Their Fabrication, a 408-page book containing a wealth of information on plates, the processes by which they are fabricated and commercially standardized formed plates such as flanged and dished heads, is available to engineers, designers and fabricators who request it on their company stationery. Request should be directed to the Lukens Steel Co., Coatesville, Pa.

A 124-page handbook, *Aluminum Structural Design,* has been issued by Reynolds Metals Company. The purpose of the book is to enable the engineer familiar with mechanics of materials to design an original structure of aluminum or to convert an existing structural design from some other material to aluminum.

Finishes for Aluminum, a 124-page book, furnishes basic information on the various processes for applying finishes to aluminum as well as the characteristics of the finishes so produced.

Both of these books will be sent to engineers, metallurgists and other company officials who request them on their company letterhead. All requests should be addressed to Reynolds Metals Company, 2500 So. Third St., Louisville 1, Ky.

Key to Savings
SHENANGO-PENN
CENTRIFUGAL
CASTINGS

Two views of a steel mill table roll body cast of Meehanite Metal by the Shenango-Penn *Centrifugal* process, assuring exceptional life. Note exterior and interior machining. Shenango-Penn facilities include modern equipment for economical machine work of virtually every type and to any stage to best meet your particular needs.

Maybe you can profit by steel mill experience

THIS conveyor roll is going to save a steel mill some money. Because it is a Shenango-Penn *centrifugal* casting of Meehanite Metal, it will hold up longer than an ordinary roll . . . won't need replacement nearly so soon! That's good economy, don't you think?

Fundamentally that's why Shenango-Penn is producing symmetrical, annular and tubular parts, large and small, ferrous and non-ferrous, for many services in many industries. The Shenango-Penn *centrifugal* casting process results in more uniform, pressure-dense parts with finer grain, greater strength, superior wear resistance and freedom from sand inclusions and blow holes. Metal for metal, dollar for dollar, they do a better job. It pays!

As always, we welcome the chance to give you further evidence, specific facts, as to why it will pay *you* to specify Shenango-Penn. Send for a free bulletin on our ferrous or non-ferrous made-to-order centrifugal castings or on our *centrifugally cast* bronze bushing stock in standard sizes.

SHENANGO-PENN MOLD COMPANY
1277 West Third Street • Dover, Ohio
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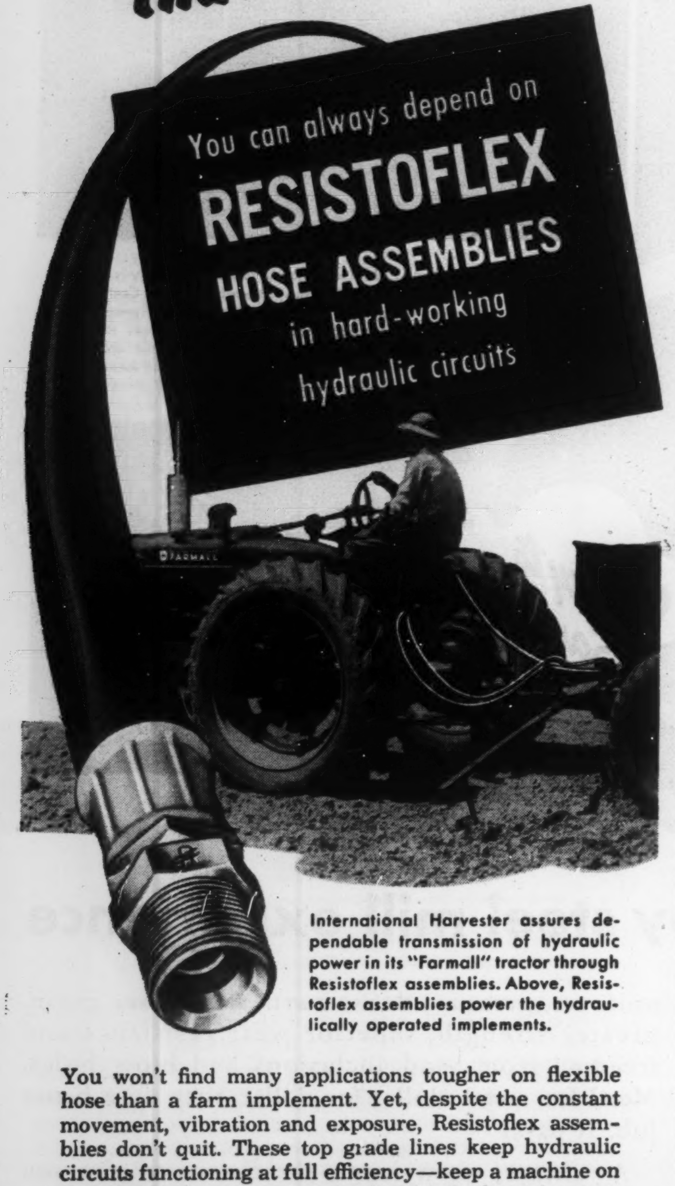
SHENANGO -PENN

ALL BRONZES • MONEL METAL
HI-RESIST • MEEHANITE METAL

Need a Hose that can take it?



International Harvester assures dependable transmission of hydraulic power in its "Farmall" tractor through Resistoflex assemblies. Above, Resistoflex assemblies power the hydraulically operated implements.

You won't find many applications tougher on flexible hose than a farm implement. Yet, despite the constant movement, vibration and exposure, Resistoflex assemblies don't quit. These top grade lines keep hydraulic circuits functioning at full efficiency—keep a machine on the go. Any time you assure that kind of service, you can take customer satisfaction for granted.

Chances are that Resistoflex lines can do an outstanding job for you, too. Not only are they completely unaffected by flexing and vibration, but they're really impervious to hydraulic fluids and oils too. You run no risk of clogged mechanisms with this non-eroding hose.

Learn more about why Resistoflex lines insure against excessive replacements and service complaints. Write us about your flexible line problem *today*.

Trade Mark Reg. in U S & Can. Pat. Off

RESISTOFLEX
CORPORATION
Belleville 9, New Jersey
SYNTHETIC FLEXIBLE PRODUCTS AND PARTS FOR INDUSTRY

News of Manufacturers

The Lincoln Electric Co. has completed final arrangements with The Austin Co., Cleveland, O., for the construction of an $8,500,000 plant to be erected in Euclid, O. The one-story manufacturing plant will contain over 850,000 sq ft of floor area on a 65-acre site on St. Clair Ave. between E. 222 st. and Babbitt Rd. Construction should be complete in 1950 for the transfer of all manufacturing operations from the present plant, which will be made available for sale or lease at that time.

◆

Acquisition of three standard machinery lines for production in its plant in Hartford, Conn., has been announced by **The Hartford Special Machinery Co.,** which has purchased the special drilling machinery line formerly manufactured by the Langelier Mfg. Co., Cranston, R. I. Also bought were the rights to manufacture an automatic thread roller machine and a die polishing machine.

◆

Purchase of a three and one-half acre tract of land in Englewood, Colo., a Denver suburb, as the proposed site of a new **C. A. Norgren Co.** plant has been announced. The Norgren company manufactures pneumatic products such as air line lubricators, filters, regulators, valves, hose couplings and assemblies.

◆

Jan-Air Inc., Richmond, Ill., manufacturers of blower wheels, has purchased the fan wheel division from the Janette Mfg. Co., Chicago, Ill

◆

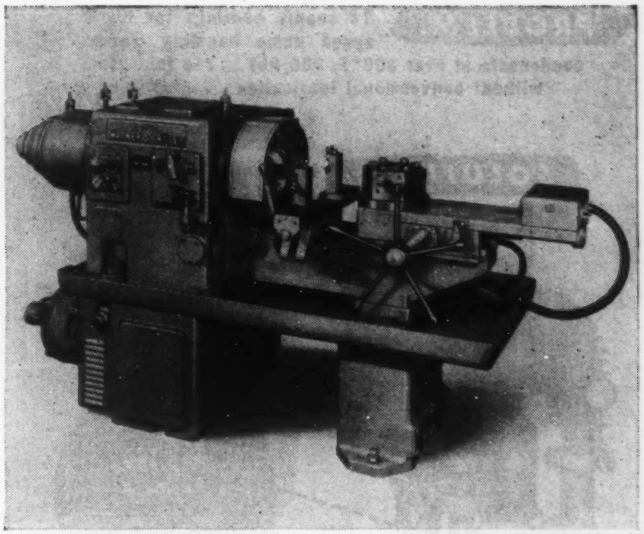
American Brake Shoe Co. announces that it has contracted to purchase from the War Assets Administration a former war plant at 344 Vulcan St., Tonawanda, N. Y. The 150,000-sq ft plant is located on a 12-acre plot near the Buffalo city line. Brake Shoe's Ramapo Ajax Div., manufacturers of railroad frogs, switches and special track work, will operate in the new property. The division plans to transfer certain operations from its Hillburn and Niagara Falls, N. Y. plants to the newly-acquired plant in the near future.

◆

A unique approach to industrial merchandising and sales promotion is the **Miller Motor Company's** "College of Cylinder Knowledge." The exhibit, housed in a 33-ft trailer which travels from plant to plant, also features an educational demonstration of how cylinder breakage, leakage and damage to seals can be eliminated. Information on the proper care and handling of cylinders is an important part of the pres-

What happens-

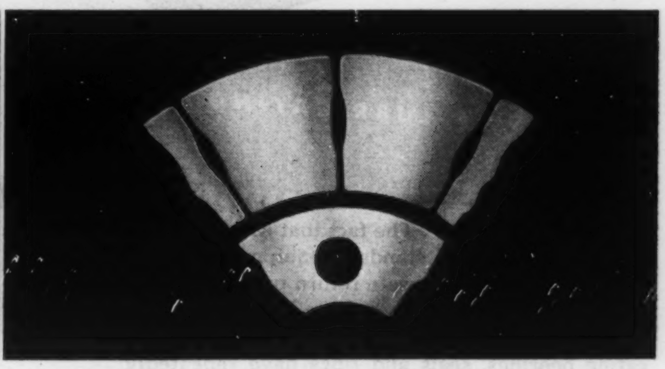
When You Give A Turret Lathe A BRAKE?



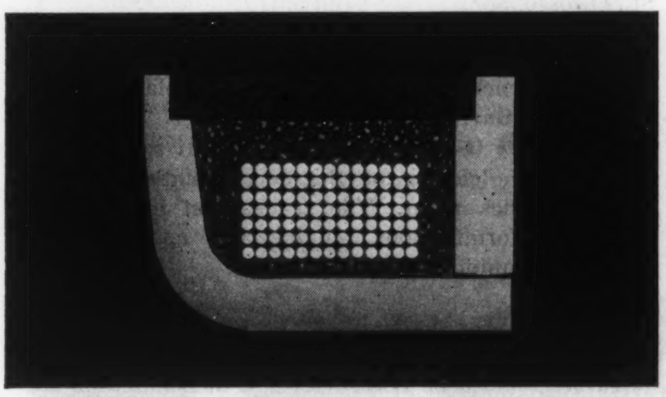
Courtesy Warner & Swasey Co.

ANSWER: You reduce machine handling time and increase production because you get fast, more fully automatic cycle operation. The W & S 16″ Electro-Cycle turret lathe, especially designed for machining non-ferrous metals, uses the Warner Electric Industrial Brake. It gives lightning fast spindle stops and closer spindle positioning — that means fast load and unload of workpieces.

THE BRAKE: Note compact design . . . readily adapts to machine or motor. Unit consists of only two parts . . . one fixed and one moving. Brake is automatically self-adjusting for life. Wide range of sizes to meet various requirements. Fits N.E.M.A. standard motor shafts.



ARMATURE SECTION: Armature is only moving part. Consists of magnetic material segments welded to steel back plate . . . for unmatched heat dissipation. Heat has no effect on efficiency . . . segment expansion is linear . . . keeps full magnet contact at all times.



MAGNET SECTION: Unique electro-magnet faced with extra long-wearing, molded friction material. Power is applied through coils imbedded below. Energizing applies friction *plus* magnetic attraction for super-powerful braking or clutch action.

Warner ICB Units* are low-cost key to more automatic, safer operation of wide variety of motors and machinery . . . give you infinite control of degree of clutch or brake action. For details or engineering assistance write: WARNER ELECTRIC BRAKE MFG. CO., Beloit, Wis.

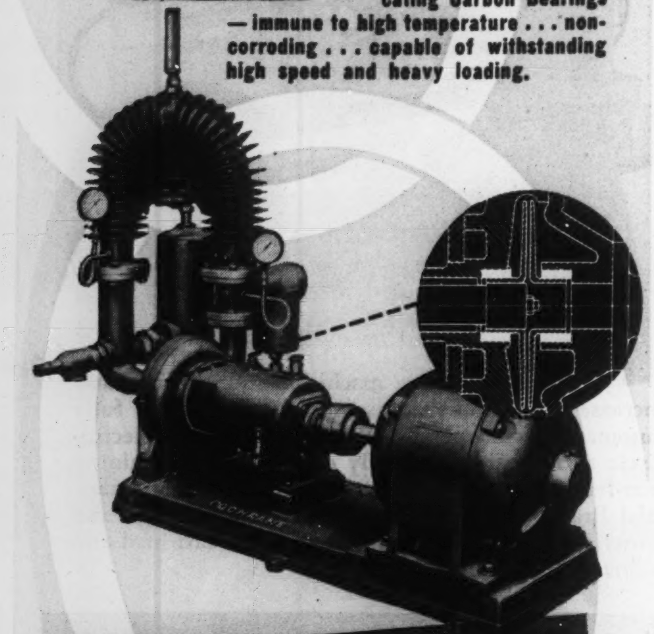
WARNER

ICB UNIT

*ICB Unit — The trade designation for the Warner Electric INDUSTRIAL CLUTCH OR BRAKE UNIT.

PROBLEM: To supply bearings for high speed pump handling steam condensate at over 300°F, 300 PSI . . . to function without conventional lubrication . . . requiring no maintenance.

SOLUTION: Morganite Self-Lubricating Carbon Bearings—immune to high temperature . . . non-corroding . . . capable of withstanding high speed and heavy loading.



MORGANITE
SELF-LUBRICATING
CARBON BEARINGS

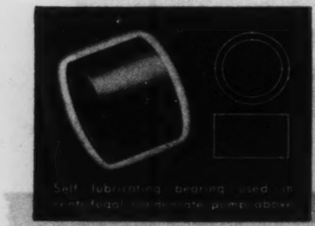
The fact that Morganite carbon bearings are standard equipment in this well-known condensate return pump is conclusive proof of performance in severe service. In this and many other applications, Morganite self-lubricating bearings, seals and rings have repeatedly demonstrated their ability to effect important economies by eliminating lubrication problems, reducing maintenance and permitting placement of bearings, seals, etc., in inaccessible locations.

See our CATALOG in SWEET'S FILE for PRODUCT DESIGNERS

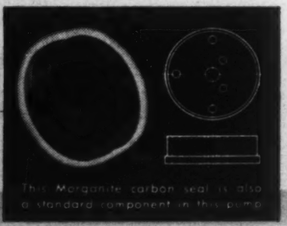
FOR DETAILS consult the Morganite Catalog in Sweets File for Product Designers; for engineering counsel or specific proposals, call in a Morganite sales engineer. There is no obligation.

REGISTERED TRADE MARK

Morganite
INCORPORATED
LONG ISLAND CITY 1, NEW YORK



Self lubricating bearing used in centrifugal condensate pump above



This Morganite carbon seal is also a standard component in this pump

Manufacturers of Morganite Carbon Brushes for all motor and generator applications, and Morganite Carbon Piles

entation, particularly to the plant operating and maintenance personnel directly responsible for hydraulic and pneumatic equipment.

◆

A one-third increase in capacity will result from the expansion of **Reynolds Metals Co.** wire, rod and bar mill at Listerhill, Ala. The enlarged mill is expected to be in full operation shortly. Expansion of the facilities accompanies the transfer of certain equipment formerly located at the Louisville, Ky., plant. The enlarged facilities will be used for the manufacture of products ranging from small wire to bar as large as 8 inches in diameter, and structural shapes ranging from ¾-inch by ¾-inch angles to a 6-inch channel.

◆

Purchase of the land and buildings formerly occupied by the **Duquesne Smelting Corp.** has been announced by the **W. E. Moore Co.** and its associated companies, Pittsburgh Lectromelt Furnace Corp., Pittsburgh Lectrodryer Corp., and West Penn Machine Shops. The newly acquired property adjoins the present W. E. Moore plants at 32nd St. and A. V. R. R. in Pittsburgh. It comprises three and one-half acres of land and 10 buildings with a total of 93,000 sq ft of floor space.

◆

Air Reduction Company, manufacturers of industrial gases and welding equipment, have opened a new oxygen plant in Flint, Mich. The plant will produce more than four million cubic feet of oxygen per month to serve the industrial needs of Flint and surrounding areas. In addition to oxygen manufacture, this plant will be an acetylene gas supply point and a store room for welding equipment and supplies.

◆

Main plant of the Michigan Sugar Co. containing approximately 95,000 sq ft of floor area has been purchased by **Mid-West Abrasive Co.,** Owosso, Mich. The building will be rehabilitated and used for storage and further expansion of the company's operations. The new property is located on West Oliver St., Owosso, Mich.

◆

Sale of General Electric's cold molded plastics business to the **Garfield Mfg. Co.,** Garfield, N. J. was revealed by the **G-E Chemical Department** as the final phase in the closing of the department's Meriden, Conn., plastics plant. The transaction includes inventories, formulations, engineering specifications, and some equipment from Meriden.

◆

Pacific and Superior Heating Divisions of the **Naco Mfg. Corp.** of Los Angeles, a subsidiary of the Grace Steamship Lines, has been sold to the **Palmer Mfg. Corp.** of Phoenix, Ariz. Mr. Palmer stated that his firm would manufacture the Pacific and Superior heating equipment from the same dies, patterns and tooling developed by Naco.

MACHINE SHOP

THE CASE OF THE Abandoned Orphan

Is the clutch in your equipment an abandoned orphan . . . deprived of its inheritance . . . with no home to turn to?

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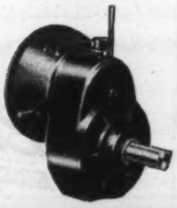
These are the reasons why manufacturers continue to standardize on Twin Disc Clutches year after year, and why they are preferred by owners and operators of all types of power-driven equipment.

Twin Disc Clutch Company, Racine, Wisconsin (Hydraulic Division, Rockford, Illinois).

Hydraulic Torque Converter

Reduction Gear



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REG. U. S. PAT. OFF.

Hydraulic Coupling

Tractor Clutch

Marine Gear

SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

Motion Analysis

(*Continued from Page* 110)

be computed but, as the approach is somewhat roundabout, explanation is necessary. It is possible to compute the acceleration of C with respect to D in a direction normal to the slot. Once this is known, the acceleration of D with respect to C normal to the slot will simply be equal and opposite.

From Corioli's Law,[2, 3] since C is a point moving along a path while the path rotates, it will have an acceleration component with respect to a fixed, coincident point on the path (D) known as the "compound supplementary acceleration." This component is directed normal to the path (slot) and its magnitude is,

$$a_{C\text{-}ND} = 2u\omega \quad (4)$$

For the position shown the rotation is clockwise and u is directed toward B. From convention,[2] $a_{C\text{-}ND}$ is directed upward, generally away from the inside of the turn. However, it is really the relative acceleration, $a_{D\text{-}NC}$, of point D on which interest centers. This is opposite in direction, that is, toward the inside of the turn, and of equal magnitude:

$$a_{D\text{-}NC} = 2u\omega \quad (5)$$

It is now possible to collect the seemingly confusing array of acceleration vectors into a logical order. In *Fig. 2b* is plotted, as far as it is possible to go, the first of the two graphical, simultaneous equations:

$$a_D \text{ with respect to } B \mathrel{+\!\!\rightarrow} a_B$$

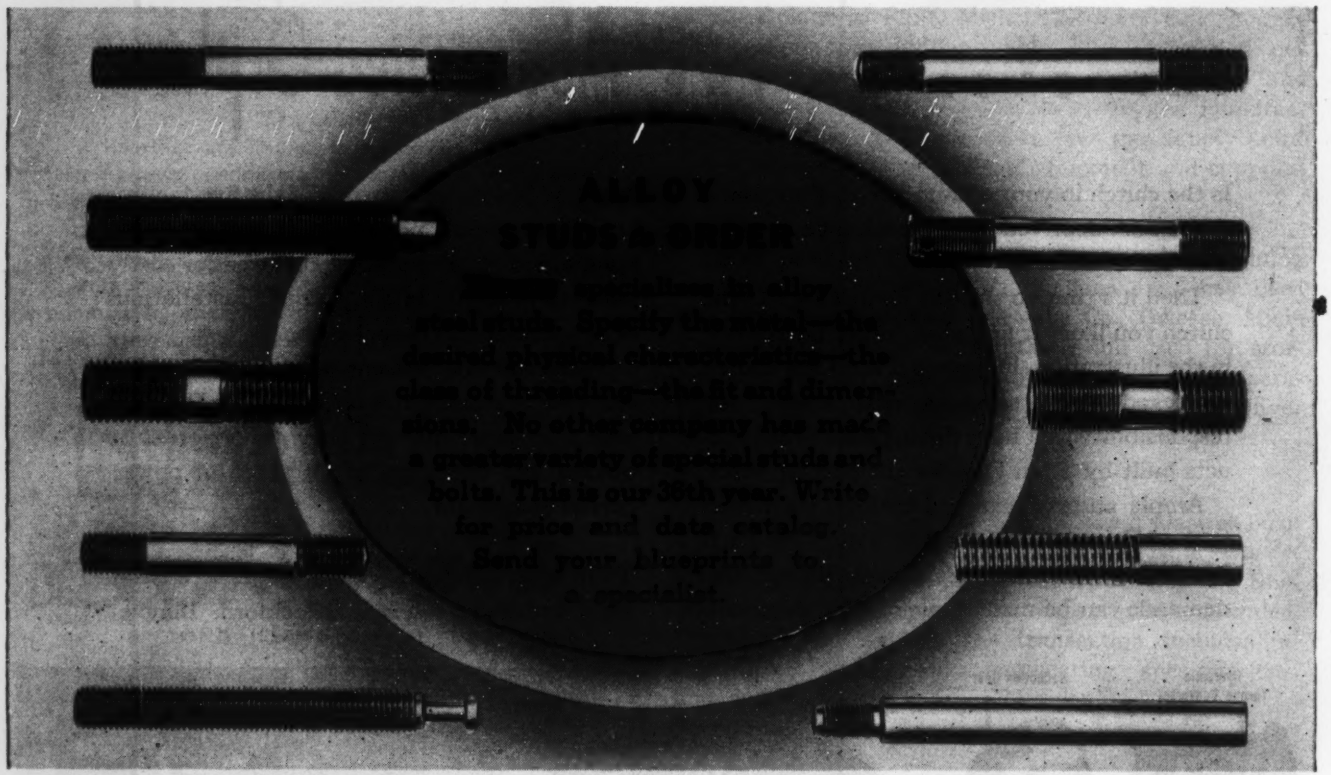
Acceleration a_B is known to be zero, therefore the total acceleration of D is a_D with respect to B. This comprises two components: $a_{D\text{-}EB}$, which is known, and a tangential component, $a_{D\text{-}TB}$, one of the unknowns for which a solution must be found. Acceleration $a_{D\text{-}NB}$ is laid out on the diagram, its vector length proportional to its magnitude and its direction parallel to the link, directed from D toward B. Although the magnitude of $a_{D\text{-}TB}$ is not yet known, its direction is normal to the link, so it is represented on the diagram as an indefinite line through the end of $a_{D\text{-}NB}$ at an angle of 90 degrees.

Second of the two equations for the total acceleration of D is plotted in *Fig. 2c:*

$$a_D \text{ with respect to } C \mathrel{+\!\!\rightarrow} a_C$$

Acceleration a_C is known and is laid out to scale, parallel to the radius AC, and directed from C toward A. Acceleration a_D with respect to C consists of a component normal to the slot, which is the second of the two unknowns to be found. The normal component is $a_{D\text{-}NC}$, which is laid out to scale from the end of the vector a_C and directed toward the inside of the turn. The parallel component is called $a_{D\text{-}TC}$ and is laid out as an indefinite line, through the end of $a_{D\text{-}NC}$ and at an angle of 90 degrees.

Because the total acceleration of D must be the same, whether expressed with respect to B or C, the



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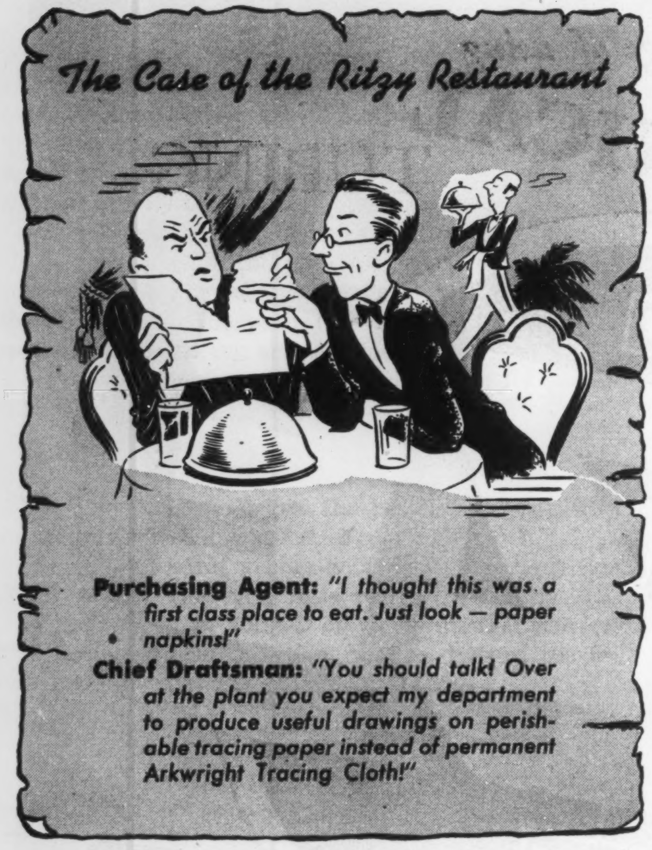

The Case of the Ritzy Restaurant

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solution may be accomplished by starting both vector diagrams from the same pole, as in *Fig. 2d.* The point of intersection of the two indefinite lines is the end of the acceleration vector for a_D and also defines the magnitude of $a_{D\text{-}TB}$ and $a_{D\text{-}TC}$.

The accelerations of two points on the link or conveyor car are now completely known for one position in rounding the turn. Acceleration of any other point, as for example the center of gravity of the car, may easily be found. The accelerations for other positions may be found by repeating the graphical construction for those positions. Finally, curves of the desired accelerations vs. distance around the turn may be plotted which will establish the maximum accelerations and the positions in which they occur.

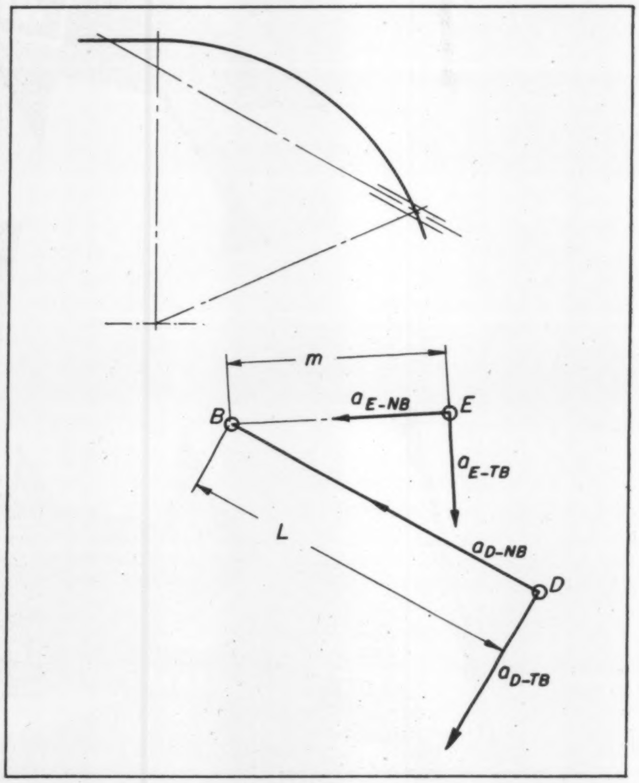

Fig. 3—Acceleration of E, any point affixed to the link or to the conveyor car. Solution is the same as in Fig. 2 except for an additional acceleration vector

TRANSFER OF ACCELERATIONS: Consider the components of the acceleration of *D* with respect to *B*, $a_{D\text{-}NB}$ and $a_{D\text{-}TB}$. Since any difference between the accelerations of two points parallel to a line connecting them can only be centrifugal acceleration, $a_{D\text{-}NB}$ can only be the function of the angular velocity, and the difference between the points, *L*. Also, since any difference between the accelerations of two points normal to a line connecting them can only be caused by angular acceleration, $a_{D\text{-}TB}$ is a function of the angular acceleration, α, and the distance, *L*.

Because all points in a rigid body must have the same angular velocity and angular acceleration, it follows that both the normal and tangential accelerations of any point in the link, with respect to *B*, must

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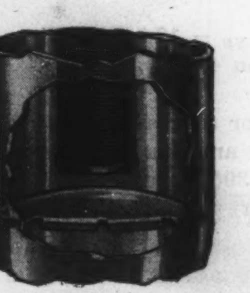

BAFFLE PLATE
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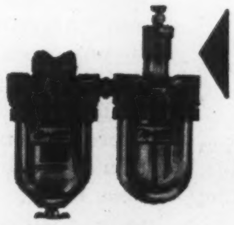

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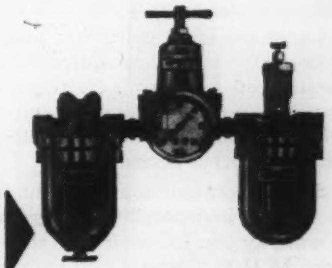

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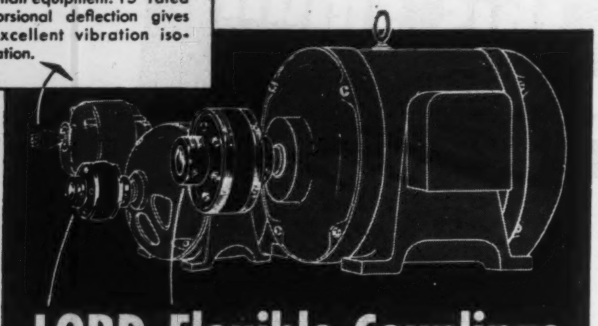
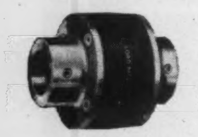
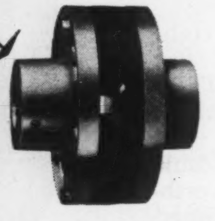


LORD Flexible Couplings

1/50 to 100 h.p.



2 TO 15 H.P. @ 1750 R.P.M.
Simple 3-piece construction. May be installed without moving equipment. No need to dismantle entire assembly. Low assembly costs. Highly flexible yet strong. 15° deflection.



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LORD Vibration Control Systems

be proportional to the distance of that point from *B*.

Referring to *Fig.* 3, *E* is any point rigidly fixed to the link or to the body of the conveyor car at a distance *m* from *D:*

$$a_{E\text{-}NB} = (a_{D\text{-}NB})\left(\frac{m}{L}\right)$$

$$a_{E\text{-}TB} = (a_{D\text{-}TB})\left(\frac{m}{L}\right)$$

The new accelerations, however, are directed normal and parallel to the new connecting line, *BE*. In all cases, once the accelerations with respect to *B* are found, the acceleration of *B* itself, if any, must be added vectorially. For all positions during entering the turn the acceleration of *B* is zero. However, when leaving the turn, *B* will have an acceleration. The procedure is the same except that there is one more vector to be included.

NUMERICAL EXAMPLE: For illustration of the method the position shown in *Fig.* 2 will be worked out. This position is 14 inches of chain travel after the leading pair of rollers contact the point of tangency. Space scale is 3 in. = 1 ft, and velocity scale is 1 in. = 10 fps. On the acceleration scale, 1 in. = 200 ft per sec^2.

Given that $V_B = V_C = 20$ fps, V_{BN} is found, by scaling, to be 9.9 fps; V_{CN} is 12.4 fps; and L is 1.25 ft. Placing these values into Equation 2, $\omega = (9.9 + 12.4)/1.25 = 17.9$ radians per sec. Scaling further, $u = 2.0$ fps and $r = 1.0$ ft. The total acceleration of C is then equal to $V^2/r = 20^2/1.0 = 400$ ft per sec^2.

From Equation 3, $a_{D\text{-}NB} = 17.9^2 \times 1.25 = 401$ ft per sec^2 and from Equation 4, $a_{D\text{-}NC} = 2 \times 2.0 \times 17.9 = 71.7$ ft per sec^2.

Laying out the vector diagram in accordance with *Fig. 2d,* the following answers may be scaled from the diagram: $a_{D\text{-}TB} = 396$ ft per sec^2, $a_{D\text{-}TC} = 163$ ft per sec^2, and $a_D = 562$ ft per sec^2.

CONCLUSIONS: Application of this method presents several distinct advantages. It defines the instantaneous conditions for each position. Other graphical methods depend on plotting a time-displacement curve and differentiating twice to obtain the accelerations. In any such method the accuracy depends upon the number of positions chosen and the closeness together. At best, all that is obtained is an average over each increment. Further, graphical differentiation is a process which, in itself, introduces considerable error. With this illustrated method, however, each position is independent of any others and is accurate within the limits of graphical construction. Once this method is set up, it can be reduced to a graphical-tabular procedure which can readily be followed by semiskilled help.

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3. Philip K. Slaymaker—"How to Determine Accelerations for Mechanisms in which Key Points Move along Paths that Rotate," MACHINE DESIGN, July, 1946.

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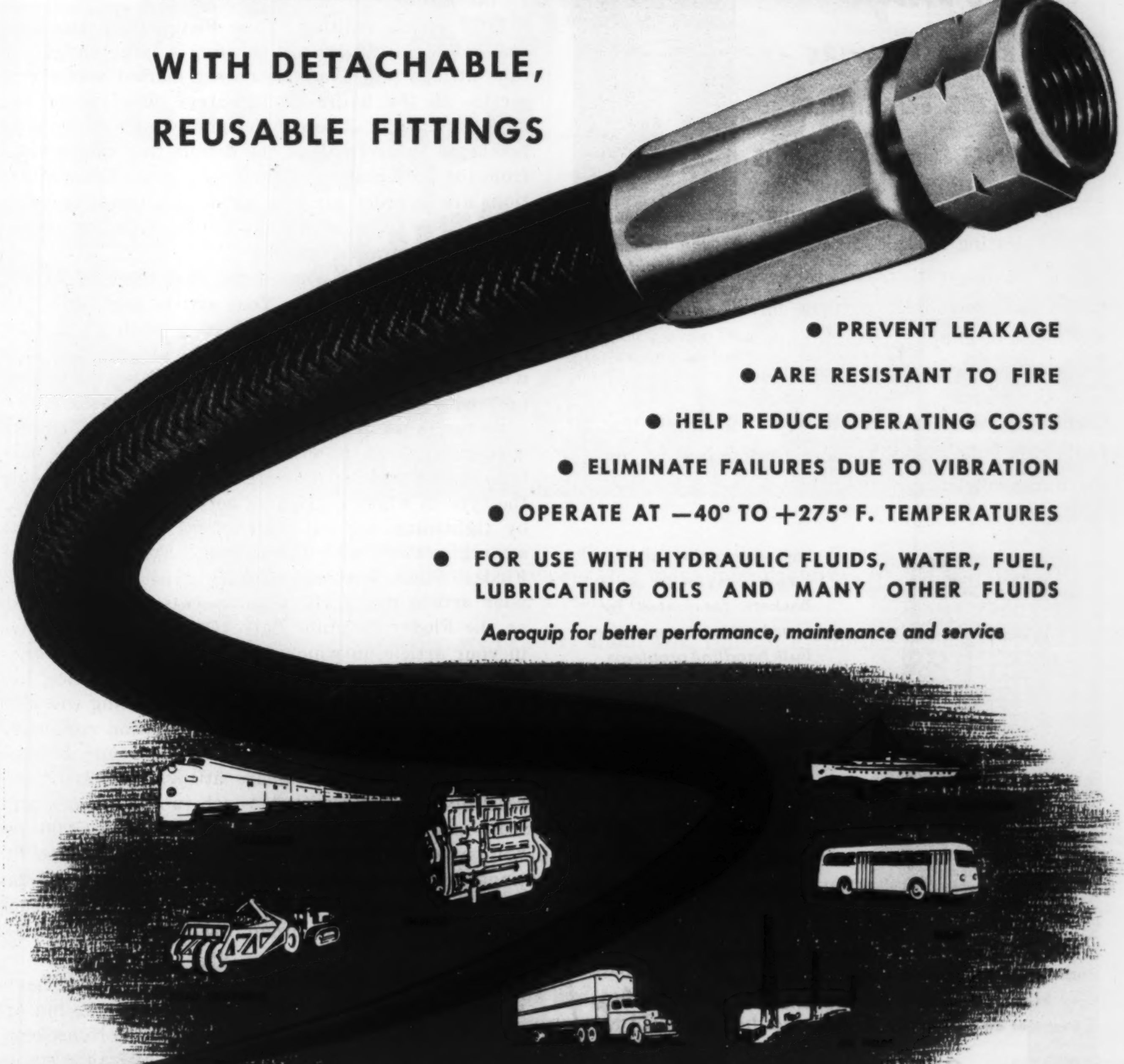

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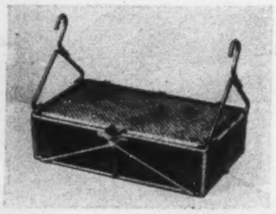

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Professional Viewpoints

". . . no standard JIC fitting"

To the Editor:

Your article entitled "Tube Fittings" in the July issue of MACHINE DESIGN showing a large variety of tube fittings now available on the market was a real service to the hydraulic industry. Because of the large number of different designs, your article could not begin to cover all of the details that might arise from the presentation of such a subject. Congratulations are in order for your splendid attempt to bring the various types of fittings to the attention of designers of hydraulic systems.

It might well be pointed out that there is no JIC Standard fitting design. Your article might give the reader the impression that there is such a standard design because of the fact that the article illustrates a duplex flare type fitting showing a 37-degree sealing nose with a nut which directly engages the flare.

So far as the requirements of the JIC standards are concerned, there is no distinction between the flare type fitting and the no-flare type, the no-flare being the type in which a gripping action is effected merely by tightening the nut which forces the sleeve into sealing contact with the tubing. For example, the Flodar Fluid Fortress no-flare type illustrated in your article meets JIC requirements equally as well as the Flodar Griptube flare type fitting also shown in your article, in which you point out that performance conforms to JIC standards. Experience has shown that the Fluid Fortress no-flare fitting will hold pressures and withstand critical vibration conditions as well as or better than most flare type fittings. Thus, Fluid Fortress no-flare fittings have been successfully operating with 1½-inch tubing under a normal operating pressure of approximately 7000 psi with a severe transient shock. Many flare type fittings would not withstand this severe duty. Flodar has other installations with smaller size tubing such as a ⅝-inch tubing circuit operating above 20,000 psi.

JIC was very careful not to adopt any requirements which would limit or inhibit advancement in the art of hydraulics. It does not give a "Good Housekeeping" type seal of approval to specific hydraulic equipment. The only real test of approval may be referred to as "buyers' approval." For example, at the outset JIC specifications point out under Section HO.1 (B) that "where new developments in hydraulics will perform in a manner equal to these specifications they will be considered as equivalent." With respect to fitting design, the door is wide open for new improvements and this is the reason why JIC could not adopt a standard fitting design for the hydraulic in-

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BLUFF

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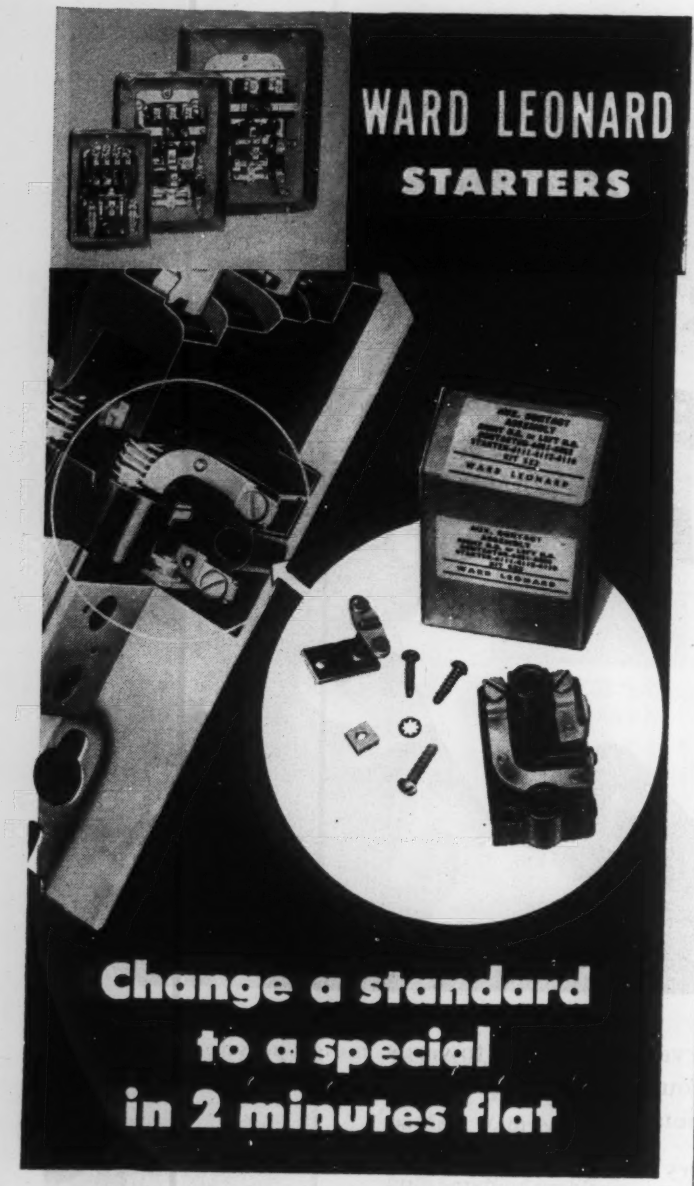

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Auxiliary contacts can be assembled on all size 1, 2 and 3 solenoid starters. Available as normally open or normally closed contacts for right or left hand mounting.

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dustry. However, there were several important details which were adopted by JIC and which enter into the design of a good fitting. One of these important details is that "All pipe threads shall be dry-seal American (National) standard taper pipe threads (NPTF)" (JIC, section H4.1.6, Paragraph (E).*). With respect to flare type fittings, the most important detail which JIC adopted is the 37-degree angle for the sealing nose as illustrated in your article. Another important detail is that all fittings for hydraulic circuits shall be made of steel and that the tubing shall be SAE 1010 dead soft, cold-drawn seamless steel. JIC further points out that the wall thickness of the tubing shall be not less than certain minimum dimensions for certain ranges of pressures. The tubing specification as adopted by JIC is one of the best things that it has done for the hydraulic industry because experience shows that hydraulic leakage is the result of inadequate tubing more often than it is from inadequate fitting design.

—G. V. WOODLING
Pres., Flodar Corp.
Cleveland, Ohio

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*"Hydraulic Standards for Industrial Equipment", MACHINE DESIGN, Dec. 1948, Pages 155-163.

Sales and Service Personnel

NEW SALES MANAGER of engineered rubber products for the Fort Wayne, Ind. plant of United States Rubber Co. is F. M. Urban. He joined the company twenty years ago as a salesman in the Chicago office. Since then he has held the positions of assistant district sales manager of the Chicago office, assistant sales manager for all branch sales in the company's mechanical goods division, and merchandise manager for this division.

◆

With the territory of Philadelphia and adjacent area, as well as certain sections of Delaware and Maryland, E. B. Osborne has been appointed sales representative for Geon plastic materials produced by B. F. Goodrich Chemical Co.

◆

Goodyear Tire & Rubber Co. has appointed William H. Abernethy special representative of the chemical division. With headquarters in Birmingham, Ala., Mr. Abernethy has been assigned to serve the Southeastern district, assuring expert technical service on Goodyear's chemical raw materials for various industries.

◆

Recently appointed sales manager for the Koppers Co. Inc. metal division is J. L. Tunstead, who fills the vacancy created by the death of McMillan Robinson.

◆

Opening of a new company to do consulting work in engineering sales and industrial relations has been announced by John D. Tebben of Detroit. Mr. Tebben has been active in the metallurgical field for many years and is well known in the electrical, aviation and resistance welding industries. He was a former vice president of the American Welding Society as well as chairman of both the Detroit and Indiana sections and has also been an active member of both the SAE and the Engineering Society of Detroit. The new company will be located at 20869 Mound Rd., Detroit, Mich.

◆

Appointment of Russell T. Woodward as manager of marketing for Telechron Inc. has been announced recently. Mr. Woodward is widely known in the electric clock, synchronous motor and timer fields, having spent sixteen years in various sales capacities with Telechron. Before joining the home office executive staff he worked for many years as sales representative and manager of the company's Cleveland office.

◆

Announcement has been made of the appointment of J. H. Ferguson to the position of district manager of the Akron branch office of the Bristol Co., 727 Grant St., Akron 11, O. Mr. Ferguson joined the Bristol Co. in 1923 as a sales engineer.

◆

The Torrington Co. of Torrington, Conn. and South Bend, Ind., producer of bearings, has appointed the following distributors: Fischer Bearing Co., with headquarters in Chattanooga, Tenn.; Tennessee Bearings Inc., 417 Dale Ave., Knoxville, Tenn.; Electric Service & Supply Co., 110 N. Grant St., Odessa, Tex.; W. P. Cunningham Co. and P. L. Walker Co., both of Houston, Tex.; and Binkleman Bearings Inc., 832 Walnut St., Toledo 1, O.

◆

According to a recent announcement, George H. Tulley has been placed in charge of metal powder sales for the Metals Disintegrating Co. Mr. Tulley will supervise the sales and servicing of present and new developments in metal powder products to present and future users.

◆

Robert S. Fleshiem has been promoted from manager of Allis-Chalmers' electrical department to assistant to W. C. Johnson, executive vice president of the general machinery division. He succeeds J. D. Greensward, recently appointed general manager of the company's Norwood, O. works. Roy M. Casper, former manager of Allis-Chalmers' motor and generator section, succeeds Mr. Fleshiem as manager of the company's electrical department.

◆

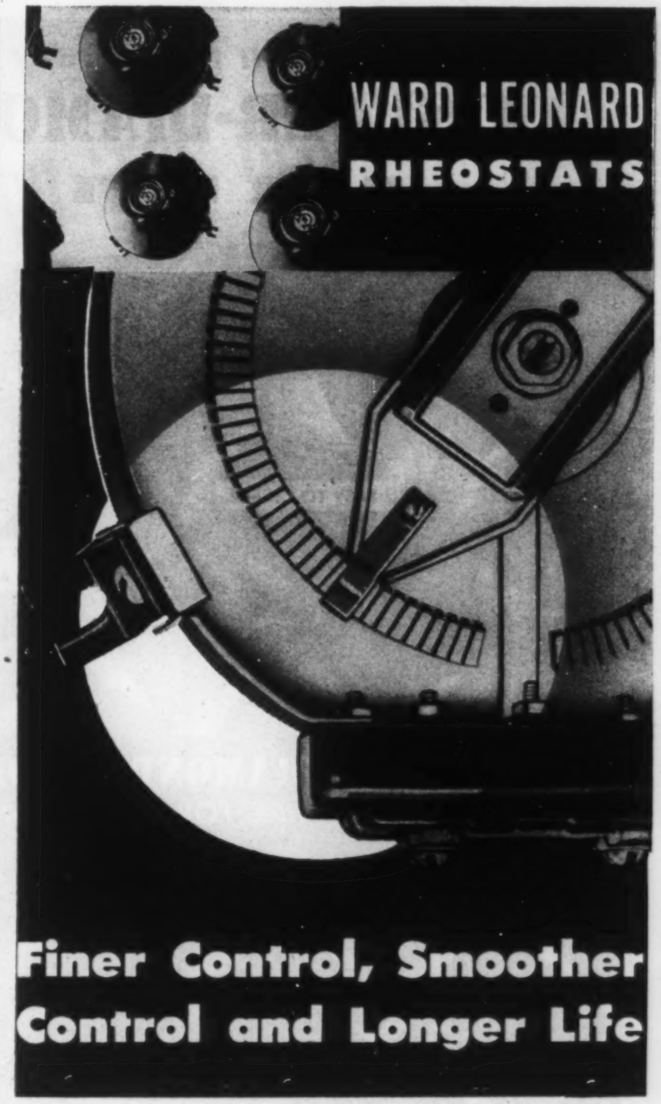
With headquarters in Cleveland, S. Chiaramonte has been named assistant sales manager of E. Horton & Son Co., to serve the Cleveland and Pittsburgh areas. He was associated for five years with the manufacture of chucks at the Cushman Chuck Co.

◆

Globe Steel Tubes Co. has announced the promotion of F. K. Krell to the position of manager of sales, welding fittings and the promotion of John F. Scott to manager of sales, stainless and alloy tubing. John Koss was made sales representative in the Chicago district, the position vacated by Mr. Krell, and J. J. Lukens was named as sales representative for the New York district, succeeding Mr. Scott.

◆

Formerly manager of the nylon technical service section for E. I. du Pont de Nemours and Co. Inc., Ambrose W. Staudt has been made manager of the market research section of the company's trade analysis division. Succeeding Mr. Staudt is George H. Braniff, who had been assistant manager of the nylon technical service section.



because of solid rectangular contacts

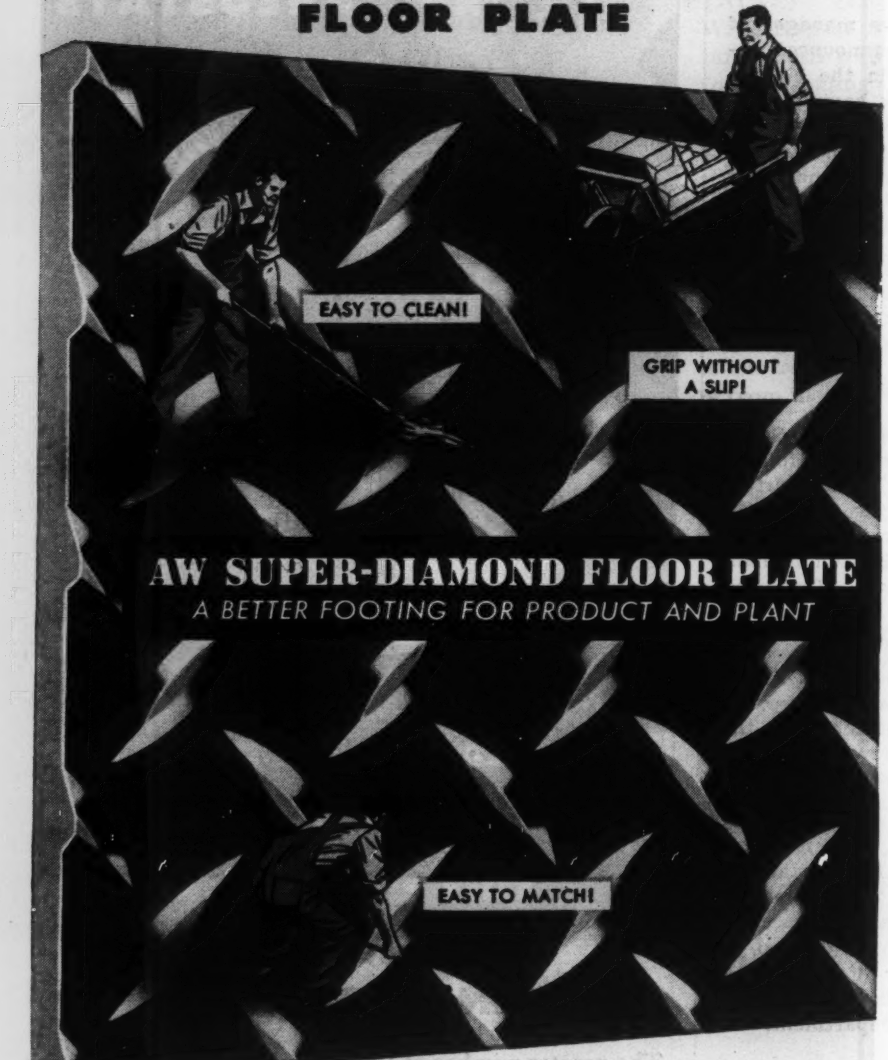
The greater number of solid rectangular contacts gives Ward Leonard multi-step rheostats finer control with smoother contact arm operation—and with all the advantages of the Vitrohm construction.

The solid metal contacts, connected to the resistance element by a patented Ward Leonard method and embedded in vitreous enamel—assures a mechanically and electrically perfect joint for long and constant service.

Write for Rheostat Catalog. Ward Leonard Electric Co., 58 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

WARD LEONARD ELECTRIC COMPANY
Result-Engineered Controls
RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES

Foundation for Safety
AW SUPER-DIAMOND
FLOOR PLATE


EASY TO CLEAN!
GRIP WITHOUT A SLIP!
AW SUPER-DIAMOND FLOOR PLATE
A BETTER FOOTING FOR PRODUCT AND PLANT
EASY TO MATCH!

So easy to plan and build with—so safe and inexpensive. Exclusive engineered design, with Super-Diamonds at 45° angles, gives grip-without-a-slip safety and makes plates easy to match without waste. Use it for safe, strong, clean loading platforms, fire escapes, walkways, trench covers, running boards, machine tool bases and other product and plant applications.

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16 Page Catalog L-59. It's packed with useful information. Write now.

AW SUPER-DIAMOND
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A Product of ALAN WOOD STEEL COMPANY
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Other Products: Permaclad, Stainless Clad Steel • AW Super Grip, Abrasive Floor Plate • Billets • Plates • Sheets (alloy and special grades)

Sales Notes

OPENING of a sales office at 504 Broadway, Gary, Ind., is announced by Cutler-Hammer Inc., Milwaukee electrical control manufacturer. This new office will be managed by F. J. Burd as a branch of the company's Chicago sales office. H. Kolar, formerly in the electrical engineering department of the Carnegie-Illinois Steel Co.'s South Chicago works, will assist Mr. Burd.

◆

New exclusive representative in the tri-state area for the B. C. Ames Co., Waltham, Mass., line of precision micrometer dial indicators and micrometer dial gages is the G. C. Wood Co., 814 Clark Bldg., 717 Liberty Ave., Pittsburgh, Pa.

◆

Arrangements have been made between Sonith Industries Inc., Indianapolis, Ind., and the Meehanite Metal Corp., New Rochelle, N. Y. for the manufacture and sale of Meehanite castings. In conjunction with their modern foundry, Sonith Industries are well known for their large and modern pattern shop which has served the foundry industry for many years.

◆

The Los Angeles branch office of Tube Turns Inc., manufacturers of welding fittings and flanges, has been moved to Suite 447 in the General Petroleum Bldg., 612 South Flower St., Los Angeles, Calif. Manager of this branch of the company is Norton P. Bosemer.

◆

In order to pave the way for the broader use of electroplated magnesium, the Dow Chemical Co. has removed all royalty fees from their plating process brought to commercial development a few months ago. This royalty-free license is applicable in the United States only and stipulates that Dow be permitted free access to any process improvements made by the licensee.

◆

Four new factory branch sales and service buildings have been constructed recently by Independent Pneumatic Tool Co., Aurora, Ill. manufacturer of Thor portable power tools. The new buildings are completely equipped service stations, conveniently located as sales headquarters for Thor distributors and

GRAMIX SELF-ALIGNING OIL-LESS BEARINGS

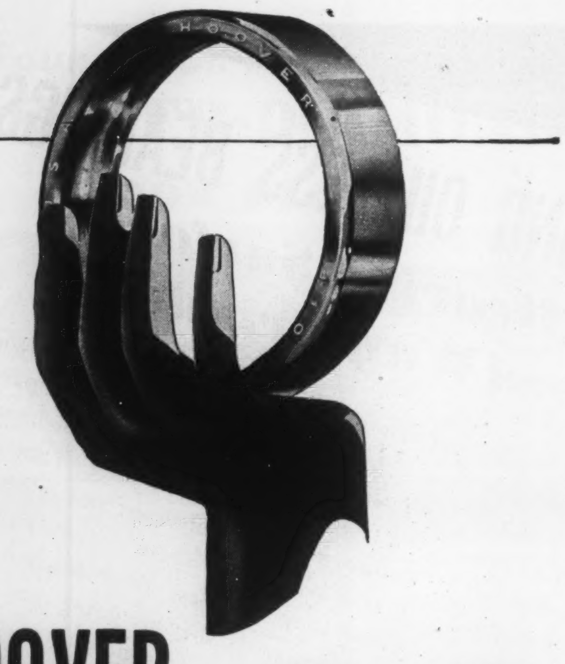
Provide 2½″ Bearing Surface on New SpeedWay Grinder

The two Gramix main bearings, with over 2½″ bearing surface supporting the drive shaft, are helping to make the ultra-new SpeedWay Bench Grinder a preferred tool in hundreds of industries because of its ability to give dependable, trouble-free service under all kinds of shop conditions. Gramix bearings were specified because they are *self aligning, need no lubrication, and cost only a fraction of similar machined parts* made of conventional materials. Gramix parts are die-pressed powdered metals, finishing to size without machining. They are porous, retaining lubricant and releasing it as required. For these reasons, and because they cost less than conventional machined parts, they are going into scores of new uses where economy and rugged precision performance are requisites.

SpeedWay
TYPE
128

Our engineers may be able
to show you how Gramix parts can
improve the performance of your product
and save you money. Write for your
copy of the Gramix parts catalog.

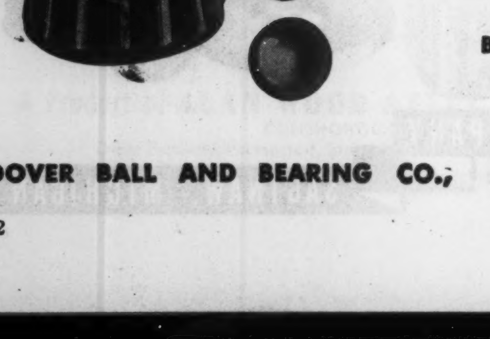
**THE
UNITED STATES GRAPHITE COMPANY
DIVISION OF THE WICKES CORPORATION
SAGINAW, MICHIGAN**



HOOVER *achieves the superb quality of hand honed raceways* ***mechanically***

The superior qualities of honed raceways were first realized in costly laboratory samples made by hand to determine just how fine a bearing could be. These samples set new standards of precision and uniformity . . . longer life . . . greater load capacity. It remained for Hoover engineers to develop the specialized machines to achieve hand honed quality mechanically. Now Hoover ball bearings, with the plus values of honed raceways, may be adopted at reasonable cost as standard equipment on all commercial products of quality. Write, on your letterhead, for a copy of the Hoover Engineering Manual.

The Aristocrat of Bearings



HOOVER

AMERICA'S ONLY BALL BEARING WITH HONED RACEWAYS

HOOVER BALL AND BEARING CO., ANN ARBOR, MICHIGAN

users. The Chicago branch is located at 1405 West Washington Blvd.; the New York building address is 32-34 Greenpoint Ave., in the Long Island City section; in Pittsburgh the building is at 204 Thomas St.; and the Toronto location is 1909 Davenport Rd.

◆

A new territorial representative for the Marcus Transformer Co. Inc., Hillside, N. J., is L. Morris Landers Co., 315 Walton Bldg., Atlanta 3, Ga.

◆

To expand facilities for serving customers, Link-Belt Co. has moved several of its offices into larger quarters. The new Cleveland office, headed by district manager Paul V. Wheeler, is located at 314 Hanna Bldg., Cleveland 15, O. In Baltimore, the office is being moved to 2315 St. Paul St., Baltimore 18, Md., under Charles C. Wiley, district manager. Headed by David W. Stevens, the Huntington office will be located at 1009 Fifth Ave., Huntington 1, W. Va.

◆

Virginia Welding Co., 114-116 Virginia St., East, Charleston 1, W. Va., has been appointed distributor for Hobart Brothers Co. Managed by W. A. Rice, this firm distributes the full line of Hobart welding equipment, including d-c and a-c arc welders, accessories and electrodes.

◆

A new warehouse point in Tulsa, Okla, has been established by Air Reduction Co., manufacturers of industrial gases and welding equipment. The warehouse will be located at Fidelity Transfer & Storage Co., 1540 East Fifth St., Tulsa, Okla.

◆

Representative for the Amperex Electronic Corp., Brooklyn, N. Y., is the S. Sterling Co. of Detroit, headed by Seymour S. Sterling.

◆

The Sturgis Products Co., Sturgis, Mich., producer of Roto-Finish materials, equipment and processes for mechanical finishing, has changed its corporate name to the Roto-Finish Co. and has moved all sales and manufacturing to its new plant in Kalamazoo, Mich.

◆

Entry of the South Wind division of Stewart-Warner Corp. into the custom production of finished machined parts has recently been announced. A wide range of manufacturing facilities will be available to customers in the form of punch press

THIS WIDE RANGE OF PUMPS MAKES SELECTION EASIER

COOLANT PUMPS
Centrifugal
Geared

LUBRICATING PUMPS
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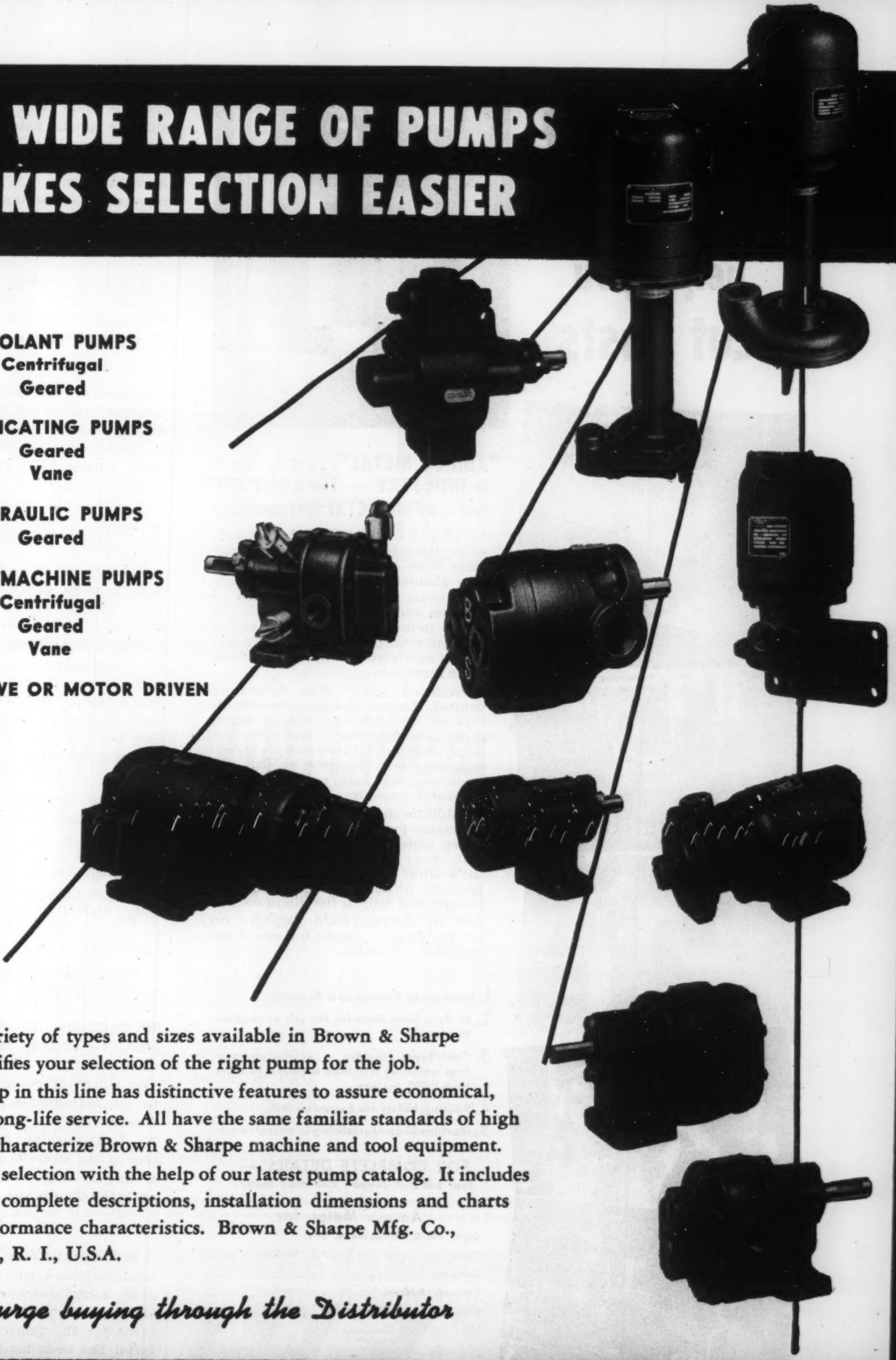
DIRECT DRIVE OR MOTOR DRIVEN



The wide variety of types and sizes available in Brown & Sharpe Pumps simplifies your selection of the right pump for the job.

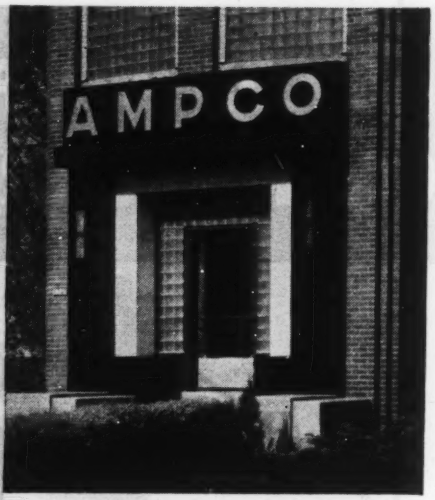
Every pump in this line has distinctive features to assure economical, dependable long-life service. All have the same familiar standards of high quality that characterize Brown & Sharpe machine and tool equipment.

Make your selection with the help of our latest pump catalog. It includes illustrations, complete descriptions, installation dimensions and charts showing performance characteristics. Brown & Sharpe Mfg. Co., Providence 1, R. I., U.S.A.

We urge buying through the Distributor

BROWN & SHARPE PUMPS

AMPCO Versatility helps you Cut Costs



"AMPCO METAL"... a by-word in INDUSTRY — The COMPANY and... a PRODUCT of that company

35 YEARS OF PROGRESS... Founded in 1914 to produce sand castings made from AMPCO METAL... a hi-iron aluminum bronze, the Company has grown steadily and expanded its facilities and the scope of its activities to the point where it is now an organization specializing in the production of non-ferrous alloys and products made therefrom.

Produced under close laboratory control, Ampco aluminum bronze alloys are available as: *sand and centrifugal castings; extruded rod, tube and simple shapes; rolled sheet and plate; forgings; arc and resistance welding electrodes; machined parts; valves; pumps and fabricated assemblies.*

In addition to aluminum bronzes (still the major product) Ampco Metal produces, under the same laboratory control, many other copper-base alloys including: phosphor bronzes; tin bronzes; nickel bronzes; manganese bronzes and Ampco Beryllium-copper.

Ask an Ampco Field Engineer for further details... make full use of our engineering service.

1

2

3

4

5

1. **Laboratory Control and Research.**
2. **Modern Sand Foundry for job or production work.**
3. **Centrifugal Foundry ... producing castings weighing less than a pound to more than 6000 pounds.**
4. **Pouring billets for Extrusion Mill.**
5. **Machine Shop specializing in aircraft work.**

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Company..
Company Address................................
City....................(...) State.........
G-3

AMPCO® **AMPCO METAL, INC.**
MILWAUKEE 4, WISCONSIN

West of the Rockies, It's the Ampco West Coast Plant, Burbank, Calif.

equipment, facilities for spot, seam, torch and arc welding, and a modern machine shop with both single and multiple spindle automatic screw machines as well as hand screw machines. A. J. Frieling has joined Stewart-Warner as field sales representative, working out of the firm's Detroit office in the General Motors Bldg.

◆

A branch office has been opened by the Ozalid division of General Aniline & Film Corp. at 912 Twelfth St., N. W., Washington, D. C.

◆

A separate mechanical spring sales division, known as Spring Products Sales Division, has been formed by American Steel & Wire Co., Cleveland. Charles W. Meyers was appointed manager of the new division, and Robert D. Knight is assistant manager.

◆

Opening of a new southeastern district sales office in Atlanta has been announced by the Wolverine Tube Div. of Calumet and Hecla Consolidated Copper Co. A. R. Kaspark has established this office and will headquarter at 788 Spring St., N. W., Atlanta, Ga., covering north and central Georgia, eastern Tennessee and western counties of North and South Carolina.

◆

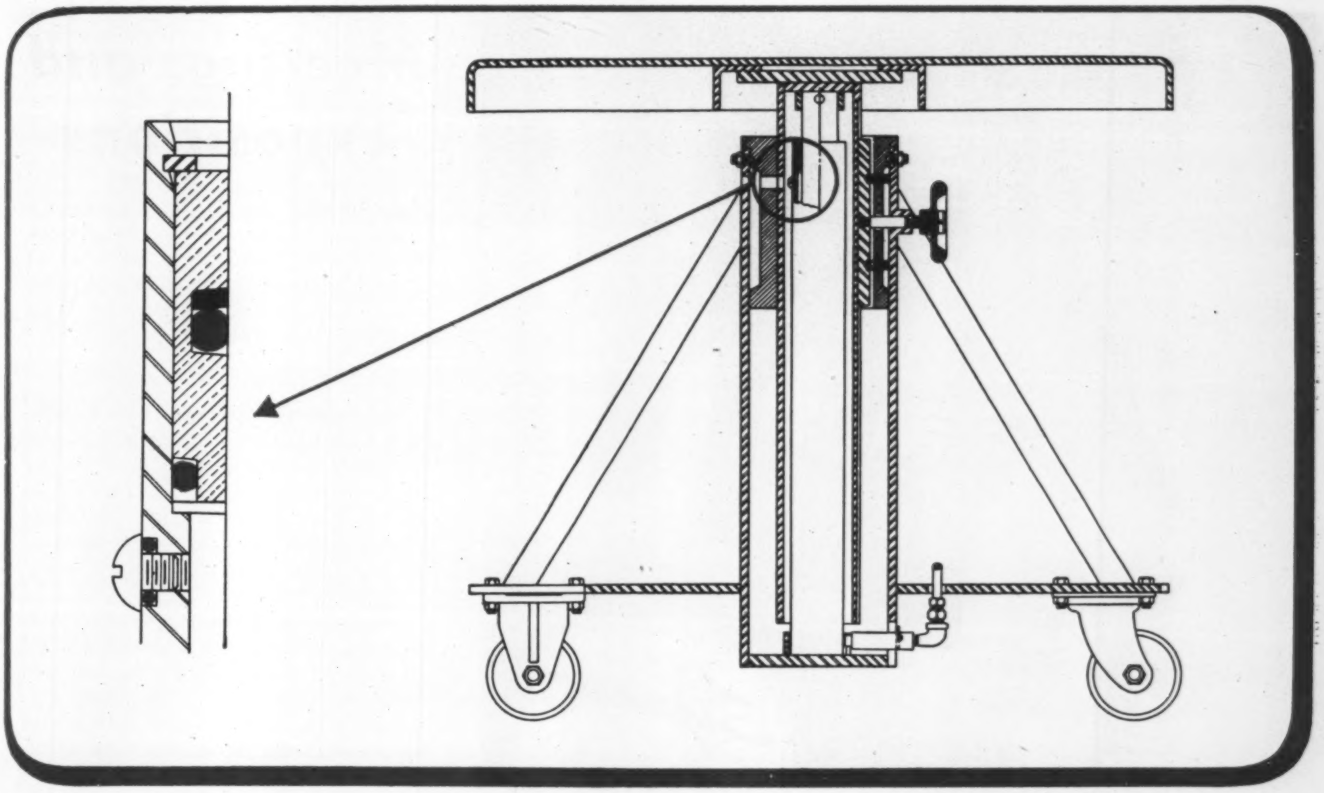
Wickes Brothers division of the Wickes Corp. has announced the opening of a factory branch ofice in the Detroit area. Joseph A. Oeming is the district manager of the new office, located at 414 New Center Bldg., Detroit 2, Mich.

◆

Air Associates Inc. has been appointed distributor of aircraft Speed Nuts and Speed Clips manufactured by Tinnerman Products Inc., Cleveland. To provide fast and efficient distribution, Air Associates will maintain stocks of popular nuts and clips in its warehouses in Los Angeles, Chicago, Dallas, Tex., and Teterboro, N. J. Tinnerman Products has also moved its Detroit district offices to a larger, more convenient location at 14550 Third Ave., Detroit, Mich.

◆

In order to meet requirements of manufacturers who wish to incorporate Johns-Manville Flexboard into their products, a working arrangement for the fabrication of this material has been made between Johns-Manville Sales Corp. and H. K. Metal Craft Mfg. Co., 3775 Tenth Ave., New York 34, N. Y.



25% Saving With Linear "O" Rings*

Another LINEAR achievement! "O" Rings used in this Lyon-Raymond Portable Hydraulic Elevating Table simplified design and effected savings of nearly 25%. After a test of 50,000 operating cycles with pressures varying from 900 p.s.i. to 2,000 p.s.i., the "O" Rings showed little wear and were effectively holding a fluid-tight seal.

Whether you require a seal for a hydraulic design or for a special service, LINEAR precision moulded packings will serve you well.

In addition to a long list of natural or synthetic rubber compounds adaptable to a wide range of temperatures, gases and liquids, LINEAR is successfully moulding "O", "V", "U" or other shapes of Kel-F, Teflon and Silicone for special applications. These special materials are suitable for seals for a wide temperature range from minus 320° F. to plus 400° F. against concentrated sulfuric, hydrofluoric, hydrochloric and other vigorous oxidizing materials.

For your individual packing design or application, CALL LINEAR.

* The use of "O" Rings in certain packing structures is covered by Christensen Pat. No. 2,180,792 under which we have paid the royalty for the installation of our rings in these structures so that the royalty is included in the purchase price of the "O" Ring.

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK STREET, PHILADELPHIA 35, PA.

Superior

ROUND & SHAPED TUBING

(.010" to 5/8" O.D.Max.)

Available in:

Carbon Steels:
AISI—MT C-1008, 1010, 1015, 1020, 1025, 1035, 1075, 1095

Alloy Steels:
AISI—4130, 4155, 52100

Stainless Steels:
AISI—303, 304, 309, 310, 316, 317, 321, 347, 403, 420, 430, 446, 502 (T-1)

Nickel Alloys:
Nickel, "Monel", "K-Monel", "Inconel"
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UNLIMITED
DESIGN POSSIBILITIES

For the instrument maker, Superior furnishes tubing in cut, multiple or random lengths, shaped to "standard" specifications—or your specialized designs. Flat and elliptical ovals for bourdon springs can be produced in any analysis shown in the accompanying table.

Superior Shaped Tubing Specification and Tolerance Sheets list all the shapes and sizes for which tools are prepared and in stock. While the specification sheets are not available for general distribution, a Superior representative will gladly call at your office to review your dimensional, analysis and delivery requirements.

You are invited to make full use of this Superior service—your request will receive prompt attention.

Superior

THE BIG NAME IN SMALL TUBING (.010" TO 5/8" O.D. MAX.)

SUPERIOR TUBE COMPANY
2010 Germantown Ave., Norristown, Pa.

For Superior Tubing on the West Coast, call PACIFIC TUBE CO., 5710 Smithway St., Los Angeles 22, Cal. • ANgelus 2-2151

188,000 SQ. FT. PRODUCING METAL TUBING

Meetings and Expositions

Aug. 15-17—

Society of Automotive Engineers. West Coast meeting to be held at the Multnomah Hotel, Portland, Oregon. John A. C. Warner, 29 West 39th St., New York 18, N. Y.

Aug. 25-Sept. 10—

Engineering and Marine Exhibition to be held in Olympia, London, England. Additional information may be obtained from F. W. Bridges & Sons, Ltd., Grand Bldgs., Trafalgar Square, London, W. C. 2, England.

Sept. 12-16—

Instrument Society of America. Fourth national instrument exhibit to be held in the St. Louis Auditorium, St. Louis, Mo. Technical sessions of the IIR Div. of ASME, Instruments and Measurements Committee of AIEE, IRE, AICE, American Institute of Physics and the National Telemetering Forum will also be held in the Auditorium. Richard Remback, 1117 Wolfendale St., Pittsburgh 12, Pa., is executive secretary.

Sept. 13-15—

Society of Automotive Engineers. Tractor division meeting to be held at the Schroeder Hotel, Milwaukee, Wis. John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary and general manager.

Sept. 26-28—

National Electronics Conference to be held at the Edgewater Beach Hotel, Chicago, Ill., under the sponsorship of the Illinois Institute of Technology, University of Illinois, Northwestern University, AIEE, and IRE. J. W. Armsey, Illinois Institute of Technology, Technology Center, Chicago 16, Ill., is publicity chairman.

Sept. 28-30—

American Society of Mechanical Engineers. Fall meeting to be held at the Lawrence Hotel, Erie, Pa. C. E. Davies, 29 West 39th St., New York 18, N. Y., is secretary.

Oct. 2-5—

American Society of Mechanical Engineers. Petroleum Division Conference to be held at the Oklahoma Biltmore Hotel, Oklahoma City, Oklahoma. C. E. Davies, 29 West 39th St., New York 18, N. Y., is secretary.

Quick, Accurate
Adjustable Speeds
from A-C. Circuits

Easy, rapid speed changes—vital in the manufacture of every roll of aluminum foil—are provided by Reliance V★S Drive.

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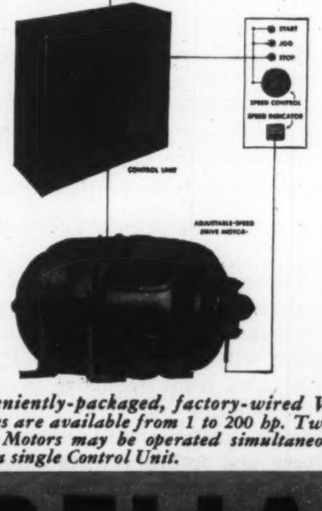
...with RELIANCE V★S DRIVE



Conveniently-packaged, factory-wired V★S Drives are available from 1 to 200 hp. Two or more Motors may be operated simultaneously from a single Control Unit.

Quick, accurate speed control that means increased efficiency in any processing has always been the primary function of the *All-electric, Adjustable-speed* Reliance V★S Drive. But the amazing flexibility which the Reliance V★S offers you also includes fast, smooth starting and stopping—inching or jogging—maintenance of proper tension—reversal at any point desired. Conveniently-packaged and factory-wired, V★S will operate from your A-c. circuit—with manual or automatic control at the machine or from remote stations. It will pay you to write today for further facts on the all-electric, packaged drive with a 10-year record of successful applications. Specify *new* Bulletin 311.

Sales Representatives in Principal Cities

RELIANCE ELECTRIC AND ENGINEERING CO.

1079 IVANHOE ROAD • CLEVELAND 10, OHIO

"Motor-Drive Is More Than Power"

Dry bulk materials flow evenly through hopper with dry aeration from a

GAST rotary

AIR COMPRESSOR

[redacted] Assure an even flow of dry bulk material through bin hoppers of portable and stationary concrete plants.

[redacted] Aeration of material around hopper opening with low pressure of 10 to 15 p.s.i., volume of 8½ c.f.m. A Gast 1065-P17 Rotary Air Compressor supplies dry, non-pulsating air at low cost with ½ to ¾ h.p. motor or V-belt from gas engine.

[redacted] Excellent. This manufacturer has used Gast Units as original equipment for many years.

[redacted] problem solved with AIR!

Whether your problem is similar—or far different from this—you too may find that "Air may be *your* Answer". As original equipment for literally hundreds of applications, Gast Rotary Air Compressors, Air Motors and Vacuum Pumps help manufacturers to improve their *products*—and *save money!*

For example, consider the Air Compressors used on this application. They deliver *positive pressure without pulsation . . .* and *without a bulky air tank . . .* at lower initial cost. And they offer many other advantages—resulting from the *utter simplicity* of their sliding-vane Rotary Design.

It may pay you to investigate the performance and economy of Gast's more than 200 models. Inquire today . . .

"AIR MAY BE YOUR ANSWER!"

WRITE TODAY!
Request your copy of this NEW booklet, "APPLICATION IDEAS"

GAST ROTARY [redacted]
(TO ONE H.P.) (TO 30 LBS.) (TO 28 INCHES)
GAST MANUFACTURING CORP., 107 Hinkley St., Benton Harbor, Mich.

Design Abstracts

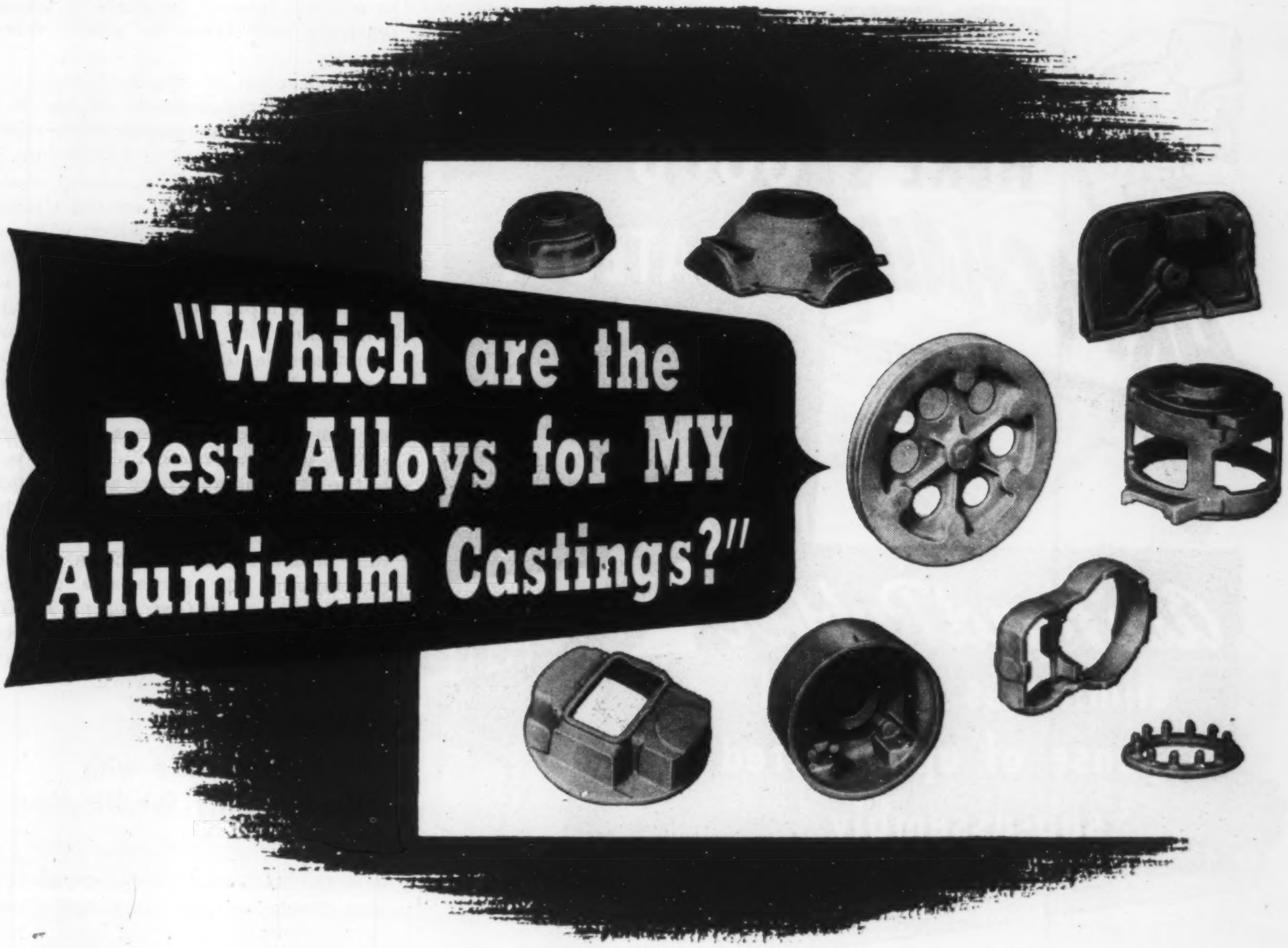
If the Enemy Strikes

VISUALIZE an enemy bombing raid of the city of New York, or Washington, or Chicago—or perhaps all simultaneously. Such an attack is within the realm of possibility at this very hour when we consider the long-distance feats already accomplished by our own B-29 Superfortresses. How would we repulse such an attack by the use of guided missiles?

Having electronically detected the approach of enemy formations, the Air Force would first dispatch high-speed interceptors. However, instead of possessing the conventional 50-caliber or 20-mm guns of World War II with an effective range of only 300 or 400 yards, these aircraft would carry air-to-air missiles which could be launched from the interceptors and proceed under their own rocket power at supersonic speeds to targets several miles away. By means of a radar homing device within the missiles, they would track down the enemy even though he might be engaged in evasive action; and, by means of a proximity fuze, they would be detonated when within lethal range of the enemy. Necessarily, such missiles must be as small and as compact as possible to allow the maximum number to be installed in our interceptor aircraft. With the basic knowledge now available, we can visualize the size, configuration and performance of such a missile. Its development into an operational missile will take only a relatively short period of time.

If Enemy Breaks Through

Suppose the enemy gets through our interceptors with their air-to-air missiles, then our surface-to-air missiles will come into action. These will be fired from defensive ground sites surrounding our strategically critical areas, such as large industrial centers and military installations. They can be guided to their targets by riding along a movable radar beam at supersonic speed, the center line of which is kept on the approaching enemy aircraft. When the missile gets close enough to the target a radar seeker will be activated. This will carry the missile into the target, or at least close enough to permit a



"Which are the Best Alloys for MY Aluminum Castings?"

IMPACT strength, elongation, dimensional stability, resistance to heat, pressure tightness . . . these are but a few of the factors which influence the selection of the right alloy for a particular aluminum casting.

Permite engineers and metallurgists through their wide knowledge of alloys for aluminum castings, have helped many manufacturers obtain the exact characteristics they need in their aluminum castings produced by Permite.

The advice of Permite engineers on your casting design in the development stage is available and highly desirable. Their recommendations often result in design modification that reduces the cost of the casting without altering its mechanical application or physical requirements.

The more than a quarter of a century of experience of the Permite organization, plus the unexcelled facilities of the modernly equipped Permite foundry, offer you definite advantages that may be translated into lower costs for your finished product.

Submit your castings requirements to Permite for recommendations and quotations without obligation.

PERMITE

ALUMINUM INDUSTRIES, INC.

CINCINNATI 25, OHIO

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ALUMINUM PERMANENT MOLD, SAND and DIE CASTINGS...HARDENED, GROUND and FORGED STEEL PARTS

HERE'S GOOD
ARMCHAIR STRATEGY!
Ace Hard Rubber
eliminates time and
expense of upholstered
sub-assembly

YES, Ace hard rubber literally knocked the stuffings out of the arm for this chair. Formerly a padded, upholstered metal stamping bolted to the chair frame, it's now a one-piece, indestructible hard rubber molding, with leather-grain finish, and a feel that's just right.

What's more, it's assembled to the chair in a jiffy. You simply slide a headed insert into a slot, flex the rubber around the curve, and run up two screws from underneath.

You too may find "a better way" in one of the many Ace hard rubber or plastics molding and extruding compounds.

If you would like to know more about these Ace materials—where used—properties—design hints, etc., just write on your company letterhead for the new free 60-page Ace Handbook.

HARD RUBBER & PLASTICS HANDBOOK

HARD RUBBER and OTHER IMPORTANT PLASTICS

ACE
AMERICAN HARD RUBBER COMPANY
Since 1851
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proximity fuze to detonate a lethal warhead and strike the enemy from the sky.

The problem of defense against attack by enemy missiles of the V-2 rocket type is considerably more complex. It will require a missile much like the V-2 itself. This missile must be launched with split-second timing to intercept its target which will approach from outside the atmosphere at supersonic speeds of at least 3600 mph. Our defensive missile must, therefore, be capable of supersonic speeds of approximately 4000 mph and of operation beyond the earth's atmosphere. Consequently, such a missile must be a multistage rocket with provisions for control out of the atmosphere where aerodynamic control surfaces are of no use. The technical complications involved in this problem render such a missile unattainable for perhaps a decade. *From a paper by Gen. Joseph T. McNarney, presented at the recent SAE National Aeronautic and Air Transport meeting in New York.*

Experience with Hardenability Specifications

ABOUT three and a half years ago the SAE and the American Iron and Steel Institute Technical Committee tentatively agreed upon a new method of ordering automotive alloy steels in accordance with hardenability as well as chemical analysis control specifications. It was hoped that this method of ordering steel would give better control of the response to heat treatment, and assure better properties in finished automotive parts. Last fall the Hardenability Division of the SAE Iron and Steel Technical Committee thought it might be well to make a survey of the automotive, tractor and aircraft industries, and determine the extent to which hardenability specifications were being used, and the results which were being obtained. Consequently, a questionnaire was circulated among a number of users of alloy steels, and 27 replies were received.

Three years ago only one manufacturer was using the new "H" band, or hardenability specifications. By last fall, however, 14 of the 27 companies replying to the questionnaire were using the new hardenability specifications and 8 more were using some sort of hardenability specifications. Only 5 did not incorporate any kind of hardenability requirements in the specifications.

The following is a brief resume of the answers of those users who have been specifying steel to the H bands and are, therefore, in the

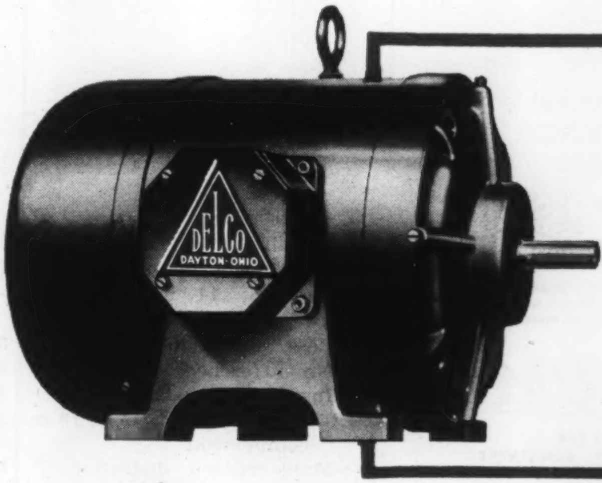
Watching production pennies?

Don't let dollars slip through your fingers!

You hear the same story everywhere. Management has laid down the law: "Get the price down per unit. Cut costs. Take out every penny you can."

That's a sound policy today, as competition gets keener. BUT . . . it can lead to *waste* and *increased costs*—lose dollars for every penny saved—if it is applied indiscriminately to production machines and motors.

Rugged, dependable Delco motors . . . built the way production men *want* their motors built . . . are the *lowest cost insurance* you can buy to keep production rolling, eliminate machine down-time caused by motor failure. Don't sacrifice other savings by taking a chance on over-age or under-built motors. Let Delco Motors help you reduce costs by raising production efficiency.



HERE'S THE "WORK-HORSE" OF YOUR PRODUCTION LINE

Size up for yourself the *extra* care and features that go into Delco Motors for *extra* performance.

- **Positioned Bearings**
- **Delcote Coil Insulation**
- **Corrosive-Resistant Cast Iron Frame**
- **Positive Lubrication**
- **Dynamically-Balanced Rotor and Shaft Assembly**
- **Water-Tight Conduit Box**

Call or write Delco Products, Dayton, Ohio or our nearest sales office.

DELCO MOTORS

DELCO PRODUCTS, DIVISION OF GENERAL MOTORS CORPORATION, DAYTON, OHIO

SALES OFFICES: CHICAGO • CINCINNATI • CLEVELAND • DETROIT • HARTFORD, CONN.

LAMINUM* Shims give .002 inch accuracy WITH AS MUCH AS .063 inch tolerance

PRECISION ADJUSTMENTS by simply peeling .002 or .003 inch laminations. *LAMINUM* shims available in thicknesses from .006 to .126 inch.

FOR SPLIT BEARING of lathe headstock spindle. Even after peeling, shim is always uniform in gauge, with a hard, clean and smooth surface.

FOR THRUST BEARING adjustment of pump. Peelable shim is valuable for takeup of wear after service, reducing "down time" for maintenance.

...cutting lathe costs
...saving assembly time

Use laminated shims, stamped from *LAMINUM,* to position machine elements accurately. With a .126 inch shim, made up of .002 inch laminations, for example, you have a full ⅛th inch of adjustment **built into** your assembly. There is NO filing or precision machining or grinding.

PLUS these advantages:

- All adjustments AT THE JOB.
- No fumbling or counting loose shims.
- No dirt, oil, grease between shim layers.
- Less compressible than ordinary one-piece shims.
- No new skill required for use.
- Can be fitted with babbitted lugs to prevent oil and pressure loss.

Send today for our new data file with specifications, design factors and applications. Sample of *LAMINUM* included. SEE OUR CATALOG IN SWEET'S FILE

STAMPING • GRINDING
METALWORKING SERVICES
Press capacity to 100 tons, 24 inches square, shallow draw. Special equipment and variety of dies can eliminate die-making for short runs. Wide stock of materials. Let us quote on your *difficult* jobs.

* *LAMINUM* (Reg. U. S. Pat. Off.) shims are solidly bonded units made up of .002 or .003 inch brass or steel laminations with a microscopic layer of metallic binder. Cut to your exact specifications.

LAMINUM
THE SOLID SHIM THAT peels FOR ADJUSTMENT
LAMINATED SHIM COMPANY, Inc.
1208 Union Street Glenbrook, Conn.

SHIMS SHIM STOCK STAMPINGS AN-COR-LOX NUTS

best position to judge the effects of ordering by this method rather than by chemical composition alone.

ELIMINATION OF INSUFFICIENT HARDENABILITY:	
Carburizing Steels	
Low surface hardness; 13 users commenting—	
Reduced rejections	1
No difference	5
Insufficient data	7
Low core hardness; 10 users commenting—	
Reduced rejections	4
No difference	4
Insufficient data	2
Heat Treating Steels	
Low surface hardness; 14 users commenting—	
Reduced rejections	6
No difference	2
Insufficient data	6
Low cross sectional hardness; 9 users commenting—	
Reduced rejections	5
No difference	3
Insufficient data	1

There were no reports of difficulty due to H steels being lower in hardenability than those purchased to chemical composition only.

EFFECT OF HARDENABILITY SPECIFICATIONS ON WARPING AND CRACKING:	
Carburizing Steels	
Quench cracking; 14 users commenting—	
Reduced rejections	1
No difference	9
Insufficient data	4
Distortion; 14 users commenting—	
Less distortion	6
No difference	4
Insufficient data	4
Uniformity of distortion; 13 users commenting—	
More uniform distortion	5
No difference	5
Insufficient data	3
Heat-Treating Steels	
Quench cracking; 14 users commenting—	
Reduced rejections	4
No difference	3
Insufficient data	7
Distortion; 14 users commenting—	
Less distortion	5
No difference	4
Insufficient data	5
Uniformity of distortion; 13 users commenting—	
More uniform distortion	5
No difference	5
Insufficient data	3

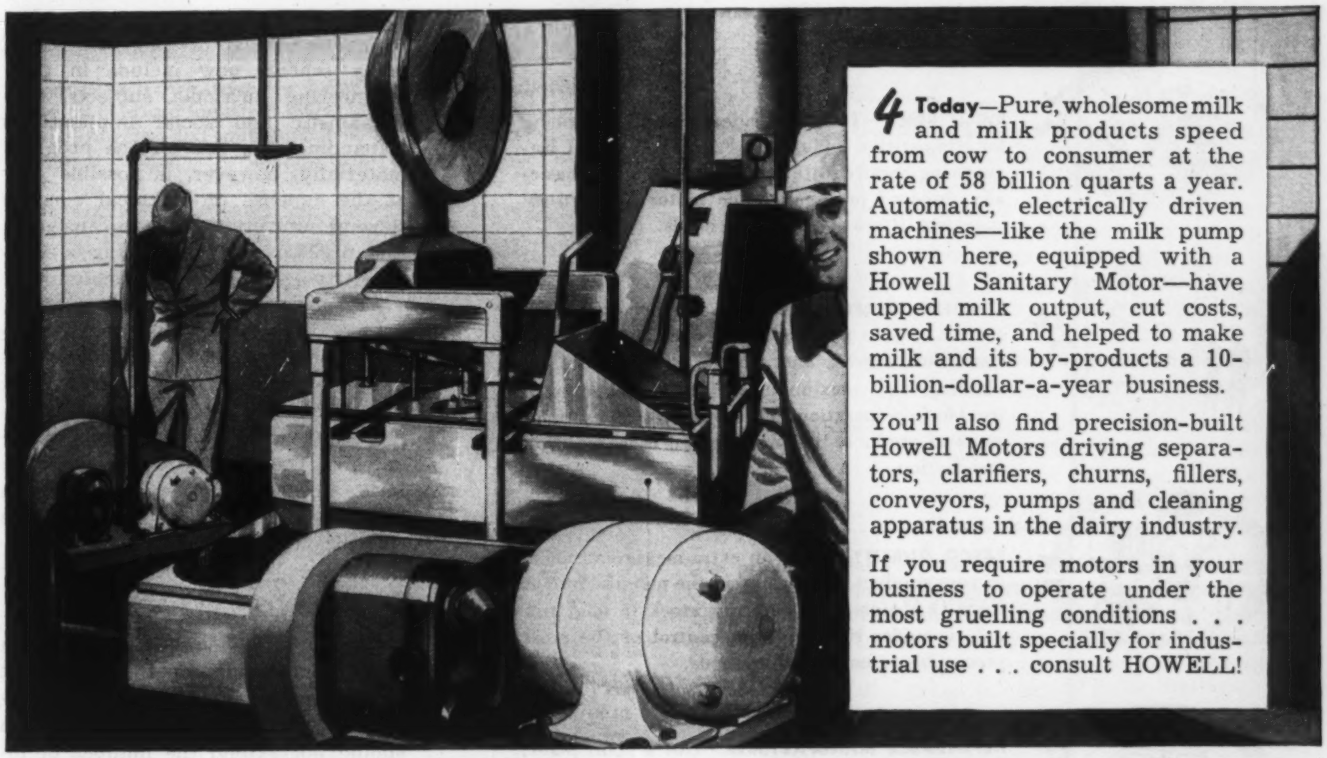
On the whole, the answers indicate that considerable improvement has been made in the elimination of the small percentage of heats which are too low in hardenability to respond satisfactorily to production

1 1770—Improvement of livestock by selective breeding boosted milk output . . . encouraged dairy farming. City folk now began to sample this wonderful beverage. But harmful bacteria in milk caused sickness, spread disease.

2 1864—France's Louis Pasteur won world acclaim by discovering how to rid milk of impurities. Milk soon became an important source of food. Vitally needed was electrical horsepower to speed it from farm to consumer.

3 1915—The year Howell Electric Motors arrived also marked the widespread use of the automatic rotary bottle filler and capper in the dairy industry. Soon, these rugged, industrial type motors were widely sought in many industries.

MILK . . . 58 BILLION QUARTS ANNUALLY!



4 **Today**—Pure, wholesome milk and milk products speed from cow to consumer at the rate of 58 billion quarts a year. Automatic, electrically driven machines—like the milk pump shown here, equipped with a Howell Sanitary Motor—have upped milk output, cut costs, saved time, and helped to make milk and its by-products a 10-billion-dollar-a-year business.

You'll also find precision-built Howell Motors driving separators, clarifiers, churns, fillers, conveyors, pumps and cleaning apparatus in the dairy industry.

If you require motors in your business to operate under the most gruelling conditions . . . motors built specially for industrial use . . . consult HOWELL!

Free enterprise encourages mass production, supplies more jobs—provides more goods for more people at less cost.

SANITARY MOTOR

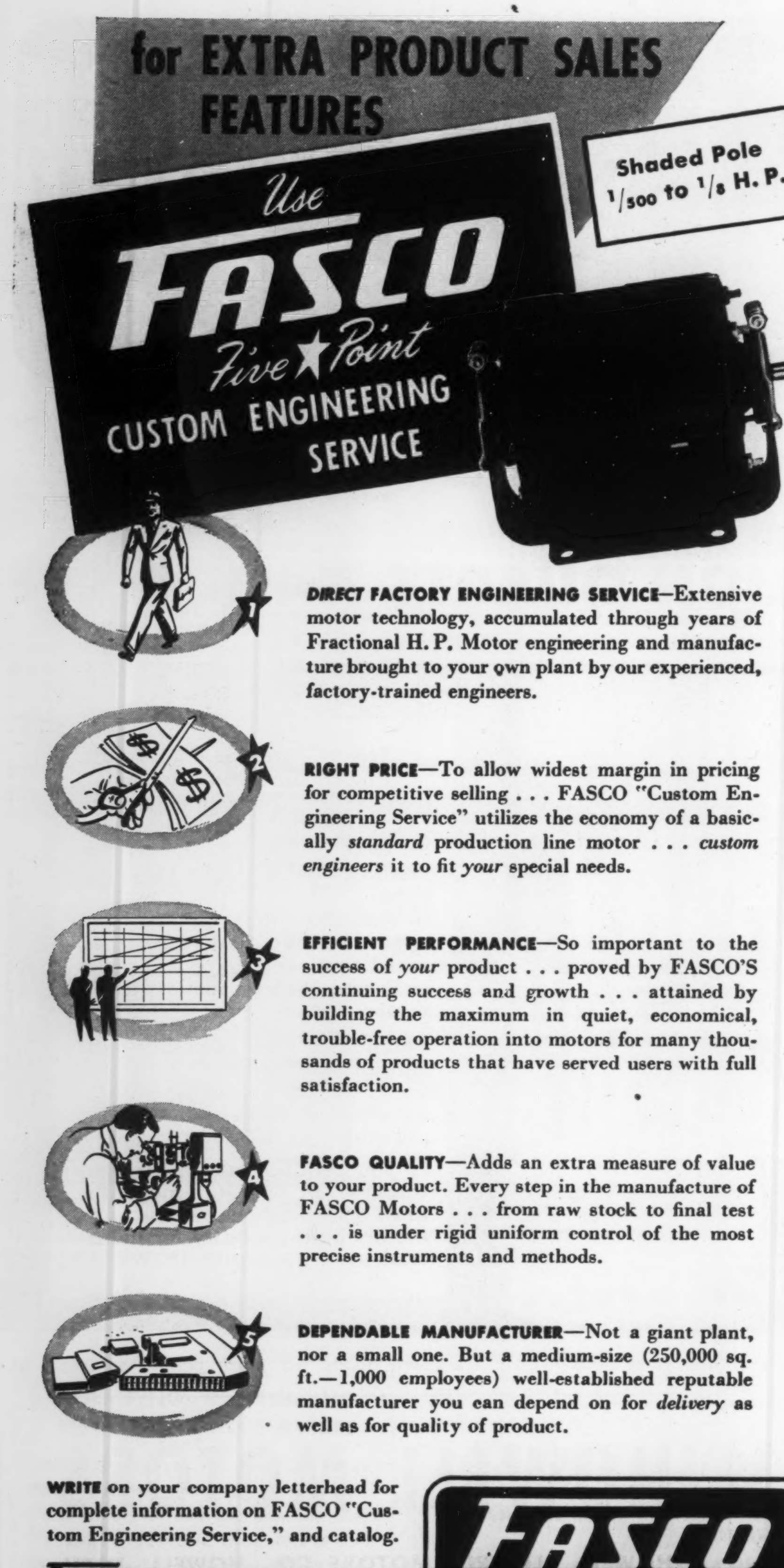
For dairy and food processing industries. Complies with latest 3-A Sanitary Specifications.

HOWELL MOTORS

HOWELL ELECTRIC MOTORS CO., HOWELL, MICH.

Precision-built Industrial Motors Since 1915

HOWELL
Red Band
MOTORS



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Shaded Pole
1/500 to 1/8 H. P.

Use
FASCO
Five ★ Point
CUSTOM ENGINEERING SERVICE

DIRECT FACTORY ENGINEERING SERVICE—Extensive motor technology, accumulated through years of Fractional H. P. Motor engineering and manufacture brought to your own plant by our experienced, factory-trained engineers.

RIGHT PRICE—To allow widest margin in pricing for competitive selling . . . FASCO "Custom Engineering Service" utilizes the economy of a basically *standard* production line motor . . . *custom engineers* it to fit *your* special needs.

EFFICIENT PERFORMANCE—So important to the success of *your* product . . . proved by FASCO'S continuing success and growth . . . attained by building the maximum in quiet, economical, trouble-free operation into motors for many thousands of products that have served users with full satisfaction.

FASCO QUALITY—Adds an extra measure of value to your product. Every step in the manufacture of FASCO Motors . . . from raw stock to final test . . . is under rigid uniform control of the most precise instruments and methods.

DEPENDABLE MANUFACTURER—Not a giant plant, nor a small one. But a medium-size (250,000 sq. ft.—1,000 employees) well-established reputable manufacturer you can depend on for *delivery* as well as for quality of product.

WRITE on your company letterhead for complete information on FASCO "Custom Engineering Service," and catalog.

FASCO INDUSTRIES, INC.
Formerly F. A. Smith Manufacturing Co., Inc.
ROCHESTER 2, N. Y.

FASCO
FRACTIONAL H.P. SHADED POLE 1/500 to 1/8 H.P.
MOTORS
and
BLOWERS

heat treatments. Distortion, warping, and cracking have been somewhat reduced. This may be due in part to reduction of maximum hardenability; however, it is believed that the smaller variation in the hardenability of steel obtained from different producing sources is an important factor. *From a report of the Steel Users Subcommittee of the Hardenability Division of the SAE Iron and Steel Technical Committee.*

Whither Education?

THE responsibility of an engineer is above and beyond that of producing materials and machines. He also has a definite responsibility to see that the devices he has created are used constructively. Recognition of this responsibility culminated, after the war, in the Report of the Committee on Engineering Education of the American Society for Engineering Education. In accordance with the recommendations of this committee, many schools now include in their engineering curricula subjects with humanistic and social implications. Expanding this part of the program materially, however, is possible only at the expense of technical courses. Several universities have answered this problem by establishing a five-year undergraduate curriculum.

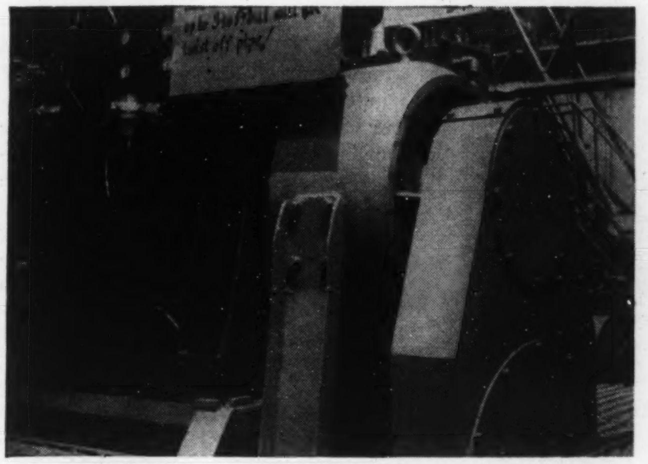
The effect upon the product of the engineering institutions, the graduate engineer, is the only accurate appraisal we can make of any program and it should be applied here. A complete answer must wait until graduates of the five-year program have been in industry long enough to be compared with those from the conventional four-year curriculum.

Proceed with Caution

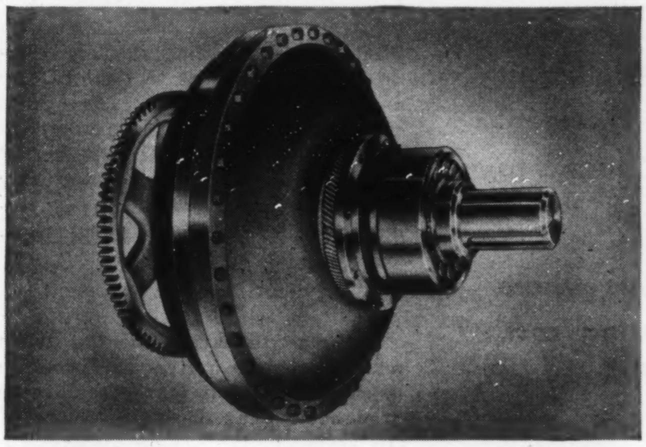
We can and should, however, reach some conclusions as to the extent of the experiment in engineering education which we are conducting. We should not extend the number of institutions with five-year curricula until we have proved experimentally the value of such a program. It is just as important for those colleges with four-year programs to continue them, to revise and improve them, as it has been for certain colleges to pioneer in organizing a five-year curriculum.

What we have failed to provide in engineering education in the cultural and humanistic areas in the past, we are now too often attempting to furnish by specific courses. I think we must recognize the limitation of the present educational method as it applies to this area particularly. The course method of instruction tends

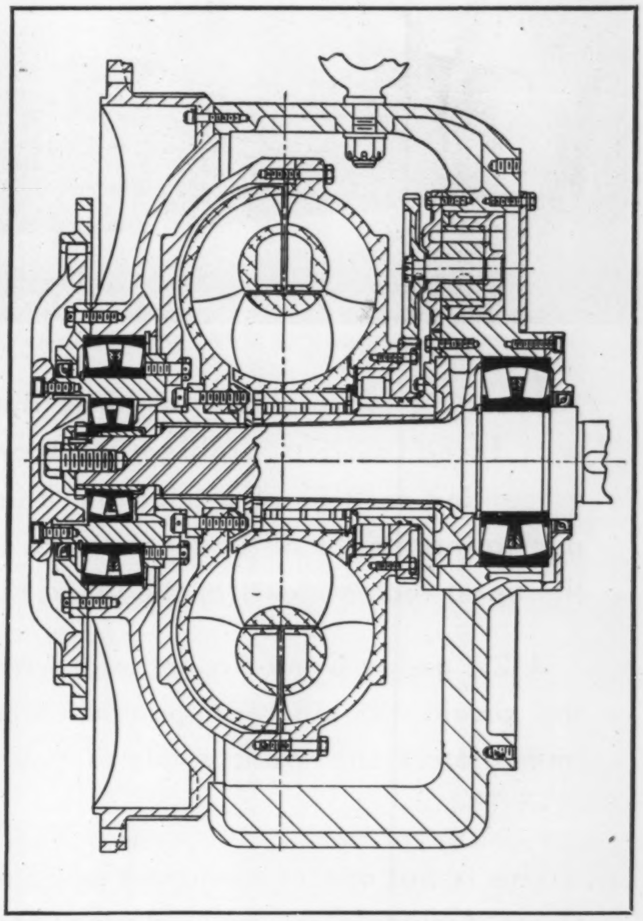
Torrington Spherical Roller Bearings Operate Freely Under Deflection in TORCON Torque Converters



An efficient transmission for a rotary table drive, above, or for other oil field and industrial machinery, the Torcon is a hydraulic torque converter and coupling in one. For smooth, trouble-free operation, it is equipped with Torrington Spherical Roller Bearings.



No detail that might increase the efficiency and reliability of the Torcon (Schneider System) has been omitted by Torcon Corporation, Chagrin Falls, Ohio. That's why high-capacity Spherical Roller Bearings are used on the input and output shafts.



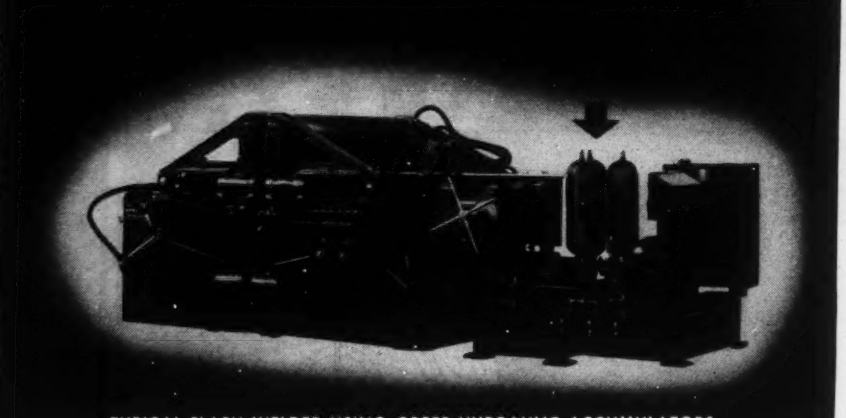
One problem solved by the use of Spherical Roller Bearings is deflection of the output shaft, caused by overhung sprocket loads. The application of self-aligning bearings, shown in cross-section, permits the use of a right angle chain drive, without an outboard bearing. Long service life is assured by the high capacity and smooth operation of Torrington Spherical Roller Bearings.

Design for greater efficiency, longer service life and lower maintenance costs with Torrington Spherical Roller Bearings. Our engineers will be glad to help you. Write us today. THE TORRINGTON COMPANY, South Bend 21, Ind., or Torrington, Conn. District offices and distributors in principal cities of United States and Canada.

TORRINGTON SPHERICAL ROLLER BEARINGS

Spherical Roller • Tapered Roller • Straight Roller **Needle • Ball • Needle Rollers**

GREER ACCUMULATOR REDUCES WORK SPOILAGE BY 24½%



TYPICAL FLASH WELDER USING GREER HYDRAULIC ACCUMULATORS

Photo Courtesy of THE FEDERAL MACHINE & WELDER CO., WARREN, OHIO, U. S. A.

A leading manufacturer of large diameter drills was faced with a problem of work spoilage amounting to 25% of production. This scrap was due to insufficient oil under pressure to cope with the upset requirements of the welder used.

A 2½ gallon Greer Accumulator was installed in the circuit. No other components were changed. Immediately the work spoilage was reduced to ½ of 1%.

This is but one of numerous applications where Greer Accumulators are reducing operating cost, increasing production and improving efficiency of processes and machines.

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Sizes from 2 cu. in. to 10 gals., pressures up to 3000 psi.

Get the complete story by writing for our free booklet. Bulletin 200.

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YOUR SYMBOL OF SERVICE
GREER
HYDRAULICS INC.
454 EIGHTEENTH ST., BROOKLYN 15, N. Y.

to assume that an individual can be divided into a number of different segments which can be independently educated and then reassembled into a composite fully educated person.

Whether we can do very much in teaching liberal subjects to men at this time in their lives I seriously question. Fundamental principles of science in engineering can be demonstrated physically in the laboratory and definitely established to the satisfaction of the student. How can he appreciate, on the other hand, what it means to solve a problem in labor relations when he has never worked in a plant or had any experience of living to appreciate the problem involved?

Our aim, therefore, in broadening the base of undergraduate engineering education should be not so much to teach the engineering student specific knowledge as to make him aware of the importance of English, economics, psychology, etc., not only to others but to him individually as an engineer. If he therefore has an appreciation of these fields, he will naturally continue his study of them far beyond the period of his formal education.

If in any particular case, however, a college determines to attack this problem indirectly through the attitudes of its teaching staff, a definite plan is essential to achieve any measurable improvement. The great danger is that the indirect approach to a solution will be so haphazard and vague that it will be essentially without plan or purpose, almost without critical and continuous evaluation.

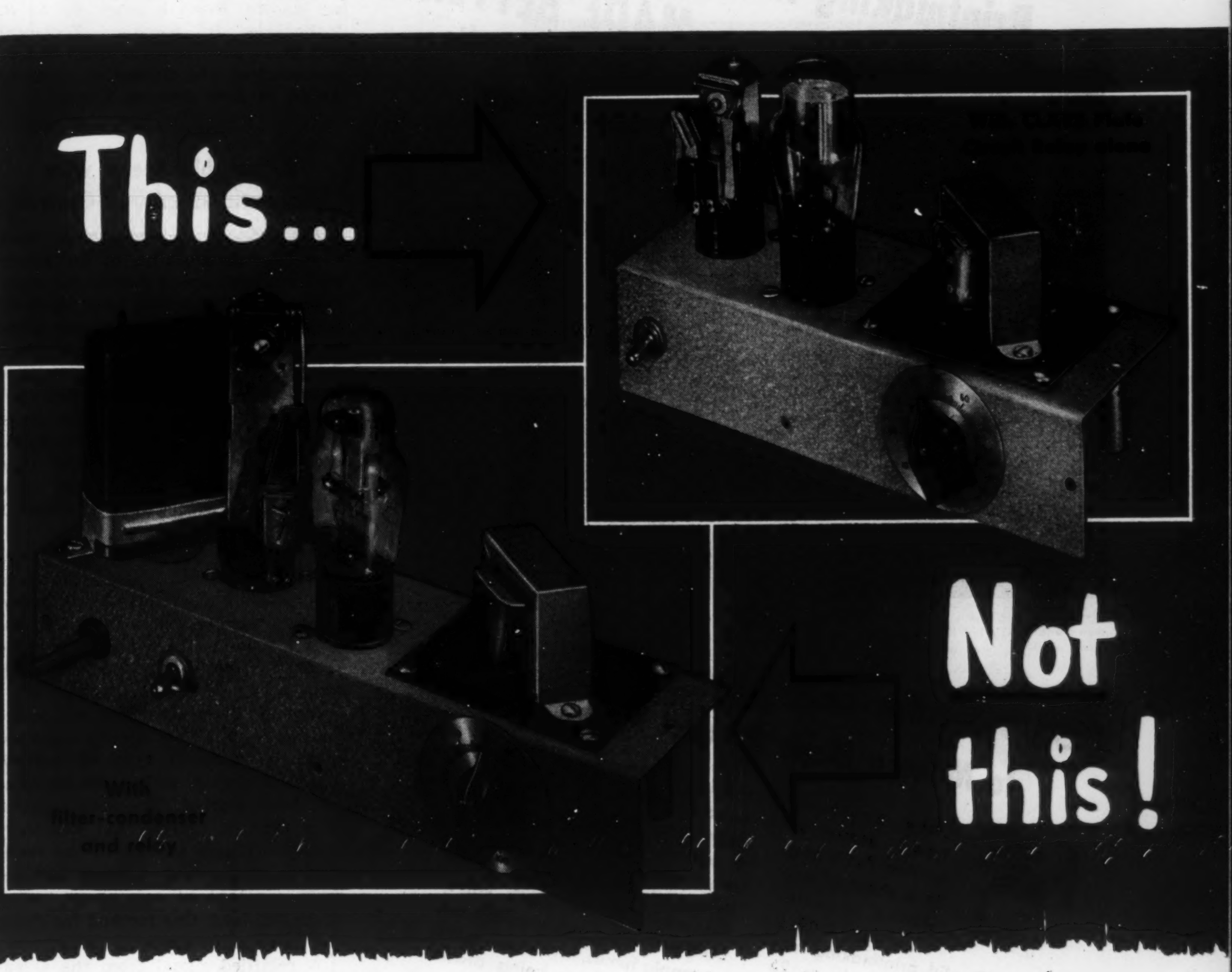
Technical Program Important

It is particularly essential when an extension to a five-year program is considered, that more pressure be brought to bear on improvement of the technical portion of the curriculum. Technical courses which are not of a most fundamental character must certainly be critically appraised and many eliminated. If some liberal education is desirable in the training of an engineer, it should not be tacked on to a technical curriculum as an after-thought but rather integrated carefully not only in the program physically but in the attitudes of the engineering faculty as well.

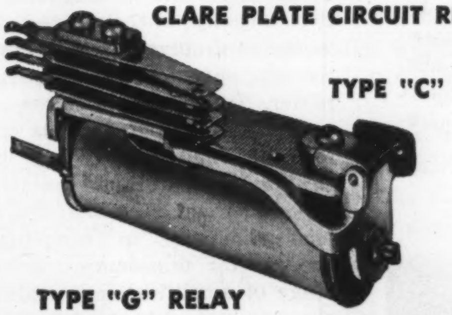
Whether one curriculum or another one can more sufficiently extend and improve engineering education is possible of proof only by demonstration. Industry will not have sufficient experience to reach a conclusion for several years. In the meantime, however, the effectiveness of the present four-year curriculum

One CLARE RELAY will do the work...

of a Relay and Filter-Condenser in Many Plate Circuit Installations

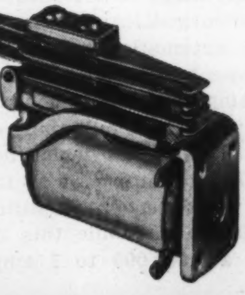

This...
With CLARE Plate Circuit Relay alone
Not this!
With filter-condenser and relay

THREE SIZES AND TYPES OF CLARE PLATE CIRCUIT RELAYS

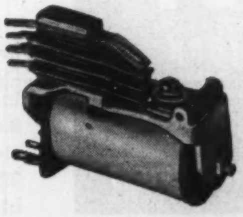


TYPE "C" RELAY

TYPE "G" RELAY



TYPE "J" RELAY



Utmost simplification of many plate circuit installations is possible with CLARE Plate Circuit Relays which make unnecessary the use of filter-condensers with or without induction networks.

By thus reducing the number of circuit elements, these CLARE Relays often make possible real savings of weight, wiring and cost.

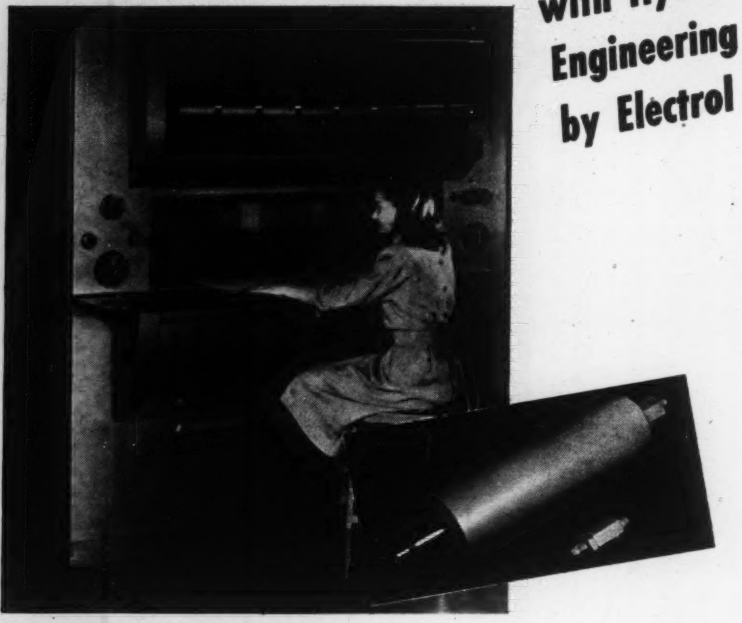
If your design involves plate circuits, it will pay you to get full information at once. CLARE sales engineers are located in principal cities. You are invited to make use of their wide experience in every problem which involves the use of relays. Call them today, or write: C. P. Clare & Company, 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address: CLARELAY.

Write for Clare Bulletin No. 104

CLARE RELAYS

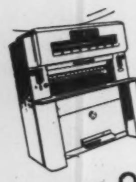
First in the Industrial Field

Printmaking Machines, too, MADE BETTER.. with Hydraulic Engineering by Electrol



The Ozalid "Super B" printmaking machine, shown with the Electrol hand pump and check valve, which are used in the developer unit.

OZALID Specifies Electrol Hydraulic Devices to Make a Major Product Improvement



Take anything typed, drawn or written. Put it next to a sheet of any Ozalid material . . . then feed it into an Ozalid printmaking machine — and in as little as 25 seconds, you will have a dry, positive, exact duplicate of your original material.

There are many reasons why Ozalid machines perform with such high speed and efficiency. One of them is the use of Electol's better hydraulic devices.

Specifically, Electrol hand pumps and check valves—made to Ozalid specifications — are used in the larger Ozalid printmaking machines, the "Printmaster" and the "Super B." The hand pump forces aqua ammonia from a storage bottle to a storage tank, from which it can be gravity-fed into the developer unit of the machine. The check valve, used with the pump, prevents air, ammonia fumes, and possibly the liquid itself, from being drawn back through the pump.

Perhaps the machines you use or the products you make can likewise be made better with hydraulic engineering by Electrol. Our engineers are at your service to recommend standard hydraulic devices, or design special units to meet your individual requirements.

Better Designed Products Use Electrol Hydraulics

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CYLINDERS • SELECTOR VALVES • FOLLOW-UP VALVES • CHECK VALVES • RELIEF VALVES • HAND PUMPS • POWERPAKS • LANDING GEAR OLEOS • SOLENOID VALVES • ON-OFF VALVES • SERVO CYLINDERS • TRANSFER VALVES • CUT-OUT VALVES • SPEED CONTROL VALVES
FOR BETTER HYDRAULIC DEVICES

is sufficient reason alone to move cautiously until the results of this experiment in engineering education are known. *From a paper by K. B. McEachron, Jr., manager, Technical Education Div., General Electric Co., presented at the Spring meeting of ASME in New London, Conn.*

Adjustable Speed with Magnetic Amplifier Control

METALLIC rectifiers have been used as a source of d-c power for adjustable-speed motors for many years. Units have been built up to 60 amperes, at 230 volts to power a 15-hp motor. As there is no convenient method of varying a-c voltage supplied to the rectifier, speed control of the motor is adjusted by a field rheostat. This limits the application of these rectifiers to that type of load which does not require more than a 4 to 1 speed range at constant horsepower.

Most power supplies for adjustable-speed motors with higher than 4 to 1 speed ranges consist of either motor-generator sets (ranges up to approximately 16 to 1), or electronic rectifiers (ranges up to approximately 100 to 1).

A metallic rectifier that will make possible comparable speed ranges requires a different type of control. The first step of such a development has been started. The step resulted in a type of control that will vary the a-c voltage applied to the rectifier so the output voltage will remain constant at any preset value, up to full load. One method for doing this uses a magnetic amplifier.

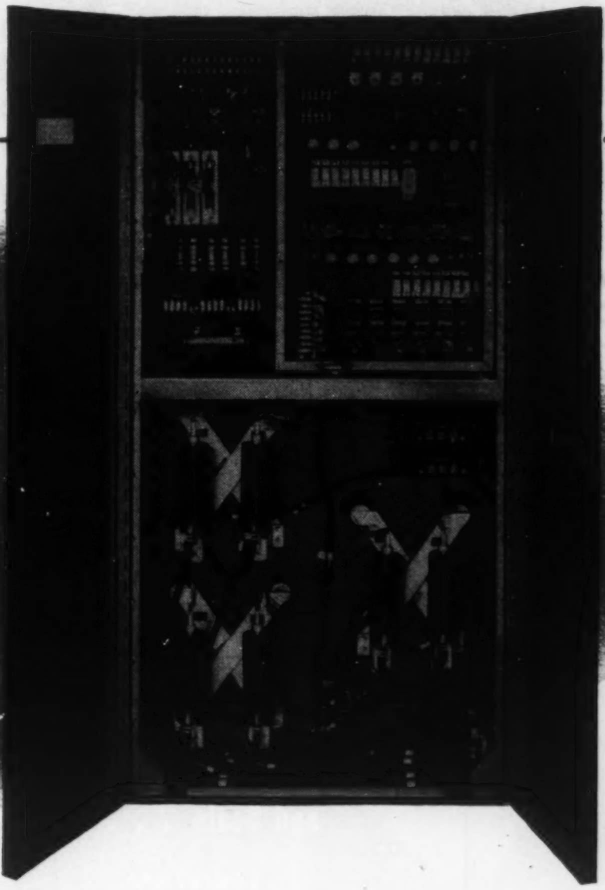
A rectified signal from the armature voltage, or a combination of armature voltage and current, or some signal from a speed indicating device is fed into a magnetic amplifier. A change in the number of watts in the controlling signal changes the wattage output of the magnetic amplifier. Power amplification of the magnetic amplifier depends on three factors: The type of iron used in the various saturable reactors; the type of circuit used and; the correct load resistance in comparison to the reactor impedance. A second stage of amplification is added when a single stage is not adequate.

One magnetic amplifier now used with automatic battery charging equipment handles approximately 600 volt-amperes. This is controlled by a current of three milliamperes flowing in a 300-ohm coil, which means that 0.0027-watt impressed on the control field produces an amplification of 222,000 to 1. While this may seem high, a 2,000,000 to 1 amplification

YOU CAN BE SURE.. IF IT'S

Westinghouse

For your Resistance Welding Applications



NOW...

a 3-PHASE CONTROL

cuts kva demand in half

Here's a new, cost-cutting answer to resistance welding problems caused by power use restrictions, excessive power costs or poor weld quality. It's the Westinghouse 3-phase, low-frequency welding control that cuts kva demand in half, while providing good welds on all types of metals.

Rusty or scaly steels, aluminum, brass and steel alloys join easily and the job goes smoothly because there's less tip pickup . . . less spitting at the electrodes. This is because the control, which is designed to spread kva over the three phases, distributes the load and provides for a smooth flow of heat into the metal. Kva demand is less because of the reduction of secondary reactance that accompanies operation at lower frequencies.

This is a complete packaged unit that controls all mechanical and electrical functions for the welding machine. It can be mounted on the floor or on the side of the machine. A swing-out panel provides easy access to all components and circuits. It can be applied to existing installations by changing the welding machine transformer.

For complete details, see your Westinghouse representative, or your local resistance welding machinery agent. Ask for B-4341. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh, Pa. J-60718

Westinghouse

ELECTRONIC CONTROL

Miller
Air Cylinders
Hydraulic Cylinders
SOLID STEEL HEADS, CAPS, AND MOUNTINGS — MACHINED FROM SOLID BAR STOCK
HARD CHROME PLATED PISTON RODS
DIRT WIPER SEALS
No Broken Castings
No Scratch-Damage
to Piston Rods, Bushings
and Seals . . .
therefore . . .
NO COSTLY "DOWNTIME" - NO REPAIRS
NO MAINTENANCE - NO POWER WASTAGE

SOLID STEEL HEADS, CAPS, MOUNTINGS. Dependable protection against the breakage that commonly occurs in "cast" cylinders when subjected to heavy shock loads in normal operation and when subjected to eccentric loads developed by cylinder misalignment. Eliminate "porosity" of castings. *Standard construction on all Miller Air Cylinders and Hydraulic Cylinders.*

HARD CHROME PLATED PISTON RODS. 90,000 to 110,000 psi yield point heat treated stress relieved steel accurately ground, polished, then *hard chrome plated.* Highly resistant to the nicks and scratches that commonly cause power wasting leakage. *Standard construction on all Miller Air Cylinders and Hydraulic Cylinders.*

DIRT WIPER SEALS. Wipe piston rods clean on every "in" stroke, protecting piston rods, seals, and bushings from scratch-damage by dirt, scum, abrasive particles. Easily replaceable. *Standard construction on all Miller Air Cylinders and Hydraulic Cylinders.*

Complete Line

- **AIR CYLINDERS** 1½" to 20" Bores
- **LOW PRESSURE HYDRAULIC CYLINDERS** 1½" to 12" Bores
- **HIGH PRESSURE HYDRAULIC CYLINDERS** 1½" to 12" Bores

Single and Double Acting, Single and Double Rod End, Spring Return, Cushioned and Non-Cushioned, Over-Sized Rod, and Long Stroke Cylinders in All Mounting Styles.

write for

Miller Air Cylinder Bulletin A-105 and Miller Hydraulic Cylinder Bulletin H-104

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Miller
AIR AND HYDRAULIC CYLINDERS · ACCUMULATORS · COUNTERBALANCE CYLINDERS · BOOSTERS · AIR HOISTS

has been realized using two stages. Indications are that this is sufficient for the majority of ndustrial applications.

The combination of a magnetic amplifier, metallic rectifiers and the necessary circuit to pick up the required control signal, should increase the field of application of metallic rectifiers when used as a power source for adjustable speed d-c motors. One combination of amplifier and rectifier produces a constant voltage output regardless of load, up to full load.

One simple circuit would give a fixed armature voltage and permit a 4 to 1 speed control by means of a field rheostat. This would give somewhat better speed regulation than that which would be obtained from a simple rectifier. Another combination can add some method of control of the output voltage, possibly over a 10 to 1 range. The voltage at any one setting would remain constant up to full load. This circuit permits speed control of approximately 40 to 1.

For good speed regulation it is necessary to have a rising voltage characteristic. The amount of voltage rise depends on the size and characteristics of the driving motor. For example, with a ½-hp motor, it may be necessary to have the armature voltage rise as much as 50 volts to maintain constant speed. A circuit to produce such a rising characteristic must include some reference to both the armature voltage and armature current. Such a circuit could produce very good speed regulation, at least at one particular speed setting. Due to slight variations in the amount of rise necessary at different speeds, it is possible to get flat speed regulation at one point, slightly rising at another point, and falling at still another point.

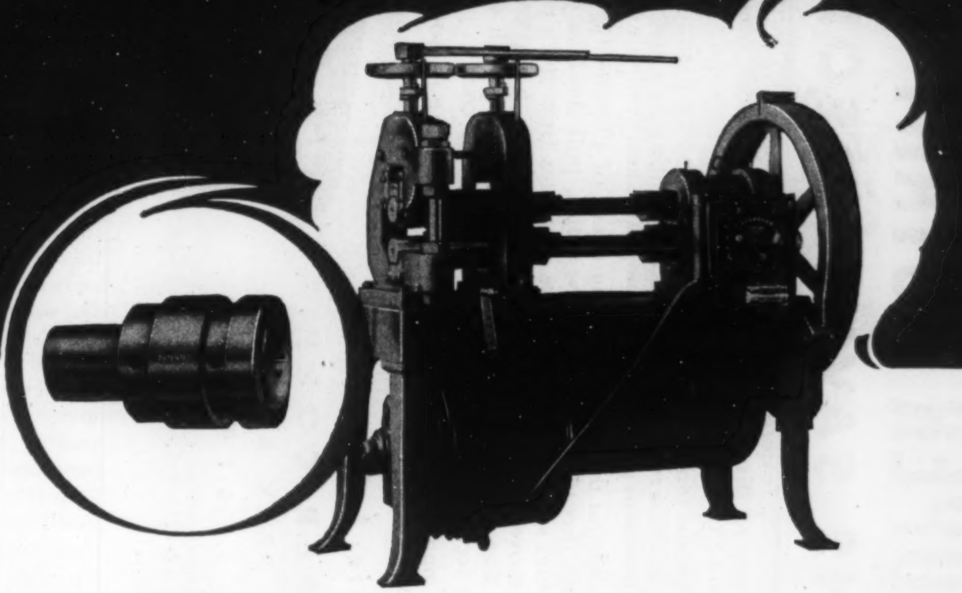
Accuracy Requirements

If accurate speed regulation is necessary, some speed measuring device must be added to the motor and its output fed into the magnetic amplifier. Actually, this type of circuit would be the easiest to build and operate, since voltage from the speed measuring device serves as a reference.

Although it is possible to build these different types of circuits, there are some factors requiring additional investigation. A major item is the time constant of the circuit. With a single-stage amplifier and a given amplification, the time constant is high. This may not be serious so far as the overall drive is concerned. If it is too high, some method must be employed to speed up the circuit by some forcing action or by the use of

THE $\$64^{00}$ QUESTION....

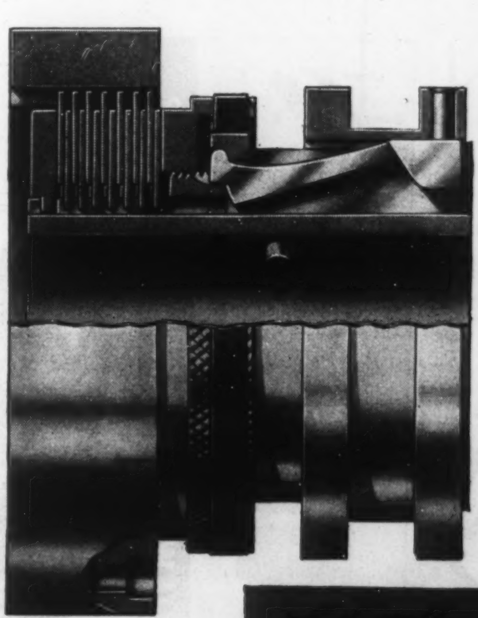
HOW LONG DO YOUR CLUTCHES LAST?



We have long known that our original clutch . . . the JOHNSON . . . was a good one but actual proof arrived the other day from Samuel Kirk & Son, Baltimore . . . "America's Oldest Silversmiths."

They asked for a few replacement parts for Johnson Clutch serial No. 64, which was original equipment in a Reverse Cross Rolling Mill, purchased from the Waterbury Farrel Foundry & Machine Co. in 1904 . . . and is still in use after 45 years of service.

The present Maxitorq Clutch . . . our compact, modernized improvement of the "Johnson"... is the result of skilled designers and careful manufacture by a company that has made clutches, only, for 46 years. We hesitate to guarantee 45 years of service, but assure you of full satisfaction when you select Maxitorq for original equipment, within its capacity . . . to 15 H.P. at 100 r.p.m. Our Engineering service is yours for the asking.



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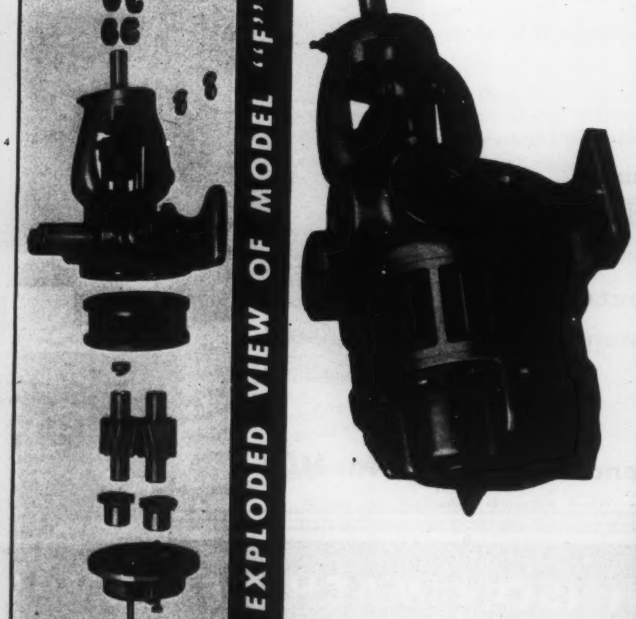
MANCHESTER • CONNECTICUT

Quick Servicing OF ROPER ROTARY PUMPS MEANS SAVINGS FOR YOU!



One of the outstanding features of Roper design is easy accessibility to working parts. It is not necessary to disturb the pump mountings, motor mountings, or pipe connections to remove the pumping gears.

When an installation requires inspection because some destructive foreign element causes trouble, quick servicing design cuts down-time and speeds the job. In addition, Roper replacement parts are interchangeable and available on all current models.

The exploded view, at the left, shows the detail of disassembly of a Series F pump. Two cap screws, threaded in jack screw holes, pull the face plate . . . front flange bearings and gears slip out easily . . . case separates from back plate and back flange bearings are removed . . . back plate, pipe connections, pump and motor mountings remain intact. The stuffing box can be repacked quickly with split-type packing by removing two-piece gland. Quick servicing at lower cost!

Roper Series F pumps (illustrated) are for pressures up to 300 P.S.I. — built in 13 sizes up to 300 G.P.M.

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ROPER Rotary Pumps

BUILDERS OF PUMPS FOR MANUFACTURING, MARINE, PETROLEUM, AND PROCESS INDUSTRIES

reactors having lower time constants.

New forms of magnetic materials will increase the field of application of magnetic amplifiers. These will effect size, weight, and probably cost reductions. New core material should also bring about lower time constants. *From a paper by J. E. Priest, Westinghouse Electric Corp., Buffalo, presented at the Machine Tool Forum, Westinghouse Electric Corp., Buffalo.*

Repairing the Frameless Car

THE unitized body stands up in service as well as the conventional frame-and-chassis car, wartime experiences with Nash cars showed, and repairs involve about the same work and cost.

Wartime experience did yield some pointers on improving unitized design. For example, certain areas in the underbody are road sandblasted. Protruding mechanical parts in certain locations are subject to this action. Experience also reveals that it is easier to seal a welded joint and prevent corrosion if the joints are on the top surface of the floor rather than the bottom.

Repair problems with the unitized body and the conventional body are identical—no more difficult or costly. In either case it is necessary to straighten out the buckled panels and box sections and gas or arc-weld in service panels, solder up, and finish.

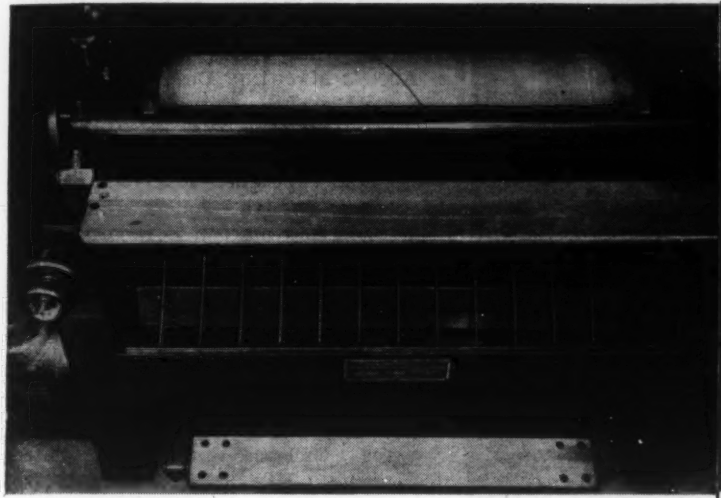
Damage Generally Localized

With the unitized construction, damage usually is localized at point of impact. Distortion or misalignment rarely extends throughout the structure. By removing attaching bolts it is comparatively easy to remove suspensions, engine, or axle units in case of repairing a body at these points. Where the body is damaged beyond repair, the problem is about the same as on the conventional car.

A recent survey disclosed that costs of repairs on Nash cars, tabulated by leading insurance companies, were comparable to that of other makes. Certain adjusters report that, since no frame straightening is required on unitized bodies, repairs can be made through sectional replacements or replacement of a portion of a section.

In many cases the cost of repairs of a Nash unitized body is less than for a conventional car with similar damage. *From a paper by Theodore Ulrich, Nash Motors Div., Nash-Kelvinator Corp., presented at SAE National Passenger Car, Body and Production Meeting, Detroit.*

Unique Bearing Application



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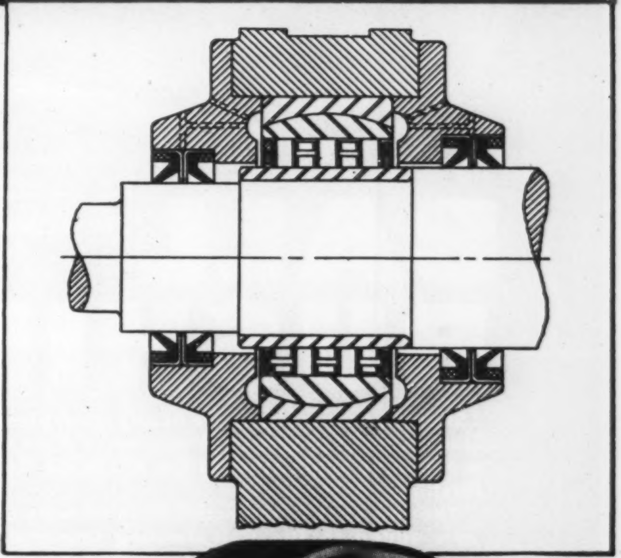
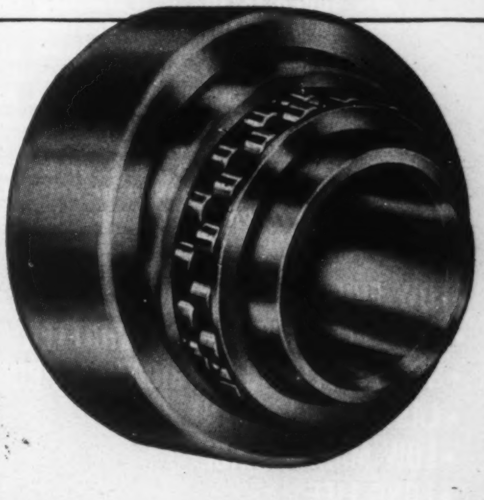
Combines Rotating and Reciprocating Action while maintaining micrometer-accuracy in operation

"Lightning" Leather Buffing and Shaving Machines, made by Curtin-Hebert Co., Inc., are used for precision buffing and shaving of leather skins. This is achieved with a sandpaper-coated main cylinder, weighing up to 1,000 lbs., which rotates at speeds up to 4,000 s.f.m., and has a fast reciprocating action while running. These amazing machines are adjustable by micrometer control to such precision settings that the print can be sanded from a newspaper page without destroying the sheet.

The bearings used on both ends of the main cylinder shaft, are a special self-aligning adaptation of Orange Staggered Roller Bearings and are designed to meet the precision specifications of the installation.

For full details on the Orange Staggered Roller Bearing design, write for Engineering Data Book. MD





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UTILITY FAN. Operates on desk, counter, floor or hanging from wall. Capacity, 2400 cfm using 18-in. fan blades. Three-speed motor enclosed in chrome-plated mount. Fan head tilts to 90 degrees. Dayton Electric Manufacturing Co., Chicago, Ill.

AIR RECOVERY UNIT. Self-contained, cell type unit for air conditioning and ventilating systems. Capacity, 1000 cfm. Air purification device has perforated filter element with face area of 28 sq ft in space of less than 3 cu ft. Unit has adsorption, or odor-holding capacity of 5 lb of condensed impurities. Service life of carbon is 3 yrs before reactivation is required. For abnormal odor concentration, 2 cells in series per 1000 cfm can be used. W. B. Conner Engineering Co., New York, N. Y.

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INDUCTION HEATER. Rated 2 kw. For soldering, brazing and hardening. Uses vacuum condensers and vacuum power tubes. Heating coil carries 100-200 amps. Operates from 200/250-volt, single-phase line. Includes forced air cooling. Sherman Industrial Electronics Co., Belleville, N. J.

Maintenance

ETCHER AND DEMAGNETIZER. For marking of tools or other parts made of iron, steel or steel alloys. Magnetization removed by placing part on work plate. Includes 14 etching heats from 90 to 1350 watts; 5 amp demagnetization capacity. Units too large to place on 7¾ by 8¾-in. work plate are marked using ground clamp and lead. Crown Industrial Products Co., Chicago, Ill.

DRYING OVEN. For baking water-soaked windings. Infra-red heating reduces drying time to ⅛ that of conventional box type oven. Handles armatures to 12-in. diameter;

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A. O. SMITH ELECTRIC MOTOR for the LeBlond Regal Lathe is an open, 2-hp motor, 1800 rpm, 220/440 v., 60 cycle, 3 phase, frame 224. Pre-lubricated ball bearings are self-protected from shop dirt and dust.

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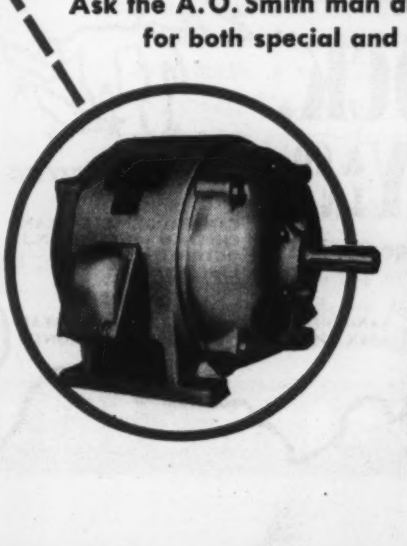

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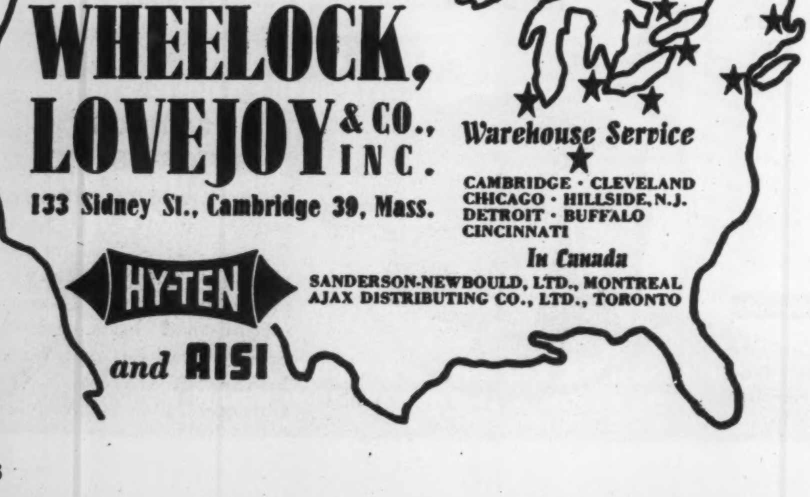

stators to 1 hp. Insulated end covers, smoke canopy and drip pan. Standard 250-watt lamps replaceable with 375-watt lamps where higher heat required. Full load rating, 9 kw. Miskella Infra-Red Co., Cleveland, O.

AUTOMATIC STAPLING HAMMER. Drives staples with ½-in. crown, ¾-in. legs. Legs diverge inside work, placing them under tension and preventing loosening by vibration. One-hand operation leaves other hand free to hold work. Bostitch, Westerly, R. I.

Manufacturing

GEAR HOBBER. For precision generation of small spur, spiral and bevel gears. Handles work from 0.050 to 6-in. OD. Hob speeds available in 12 steps from 109 to 1259 rpm. Hob spindle turntable swivels 105 degrees left and 135 degrees right. Machine operates on 1-hp motor, affords helix leads from 0.800 to 130 in. Speed, feed and indexing can be selected independently. Hamilton Tool Co., Hamilton, O.

CONTOUR CUTTER. Uses standard acetylene blowpipe to automatically reproduce any desired pattern in sheet or plate steel. Capacity, from ¾-in. holes to 5-ft diameter shapes. Pattern-tracing finger incorporates variable speed, magnetic rotor with ¼-in. diameter. Optional operating speeds permit adjustment to accommodate any gage steel or production procedure. Heath Engineering Co., Fort Collins, Colo.

ABRASIVE MATERIALS COMPRESSING MACHINE. Rotary machine for handling materials such as powdered glass, ceramics and powdered metals. Produces compressed parts up to ½-in. diameter at rates to 300 per minute. Can also produce parts having cored holes. Press applies 2½ tons pressure from above and below; 1-hp gear-head motor mounted vertically above die area to prevent abrasives entering motor. F. J. Stokes Machine Co., Philadelphia, Pa.

MILLING AND CENTERING MACHINE. For continuous rough and finish milling and centering of work simultaneously on both ends. Handles work pieces from 12 to 45-in. long. Size of work determines number of stations in rotary drum type fixture. Six-station fixture handles work pieces to 4-in. diameter. Cutting speed of 10 in. per minute produces 50 pieces per hour. Eight-station fixture handles work to 2½-in. diameter, producing 65 pieces per hour with same cutting speed. Davis and Thompson Co., Milwaukee, Wis.

PORTABLE GRINDERS. Air powered, in 6 and 8-in. sizes. Weight, 14 lb.

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BELT SANDER. Air driven, designed for metal work on either concave or convex surfaces. Suitable for sheet metal and solid castings and all types of materials such as iron, steel, brass, bronze, solder, aluminum, etc. Weight, 11 lb. Requires 90 psi air to run at 6000 rpm. Abrasive belts are 2 in. wide and of various grits. Buckeye Tools Corp., Dayton, O.

BROACH SHARPENER. For internal and surface broaches to 36-in. long and 6-in. diameter. Round broaches inserted between motorized, 2-speed headstock and quick-release, spring-loaded, center tailstock. Adjustable plunger limits wheel travel for faster grinding. When grinding flat broaches, head and tailstock are replaced by magnetic chuck. Colonial Broach Co., Detroit, Mich.

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LATHES. Engine and tool room models in sizes from 14 to 32 in. Include 16 spindle speeds, increased horsepower capacities, 3-lever gear shifting system without pass through gears, and newly designed feed box incorporating lifetime lubricated, sealed ball bearings. Range of 60 threads and feeds available, with optional ranges including 11½ and 27-pitch thread leads in addition to other pitches. Springfield Machine Tool Co., Springfield, O.

PRECISION TURRET LATHE. Redesigned model 2-H. Includes turret locking mechanism that indexes turret head within plus or minus 0.0005-in. measured 4 in. from turret face. Max swing over bed, 16¼ in.; swing over cross slide, 6⅞ in.; max collet capacity, 1 in. round; hole through spindle, 1⅜ in. Friction clutch drive gives 48 power cross-feeds from 0.0006 to 0.312-in. and 48 power longitudinal feeds

NATIONAL OIL SEAL LOGBOOK

COMPENSATING FOR THE EFFECT OF CENTRIFUGAL FORCE ON THE SPRING TENSION OF OIL SEALS

In applications where large diameter oil seals rotate with the mechanism at high speeds, centrifugal force tends to lift the sealing member from the stationary sealing surface. Critical adjustment of spring tensioning in the oil seal is required in order to compensate for this effect.

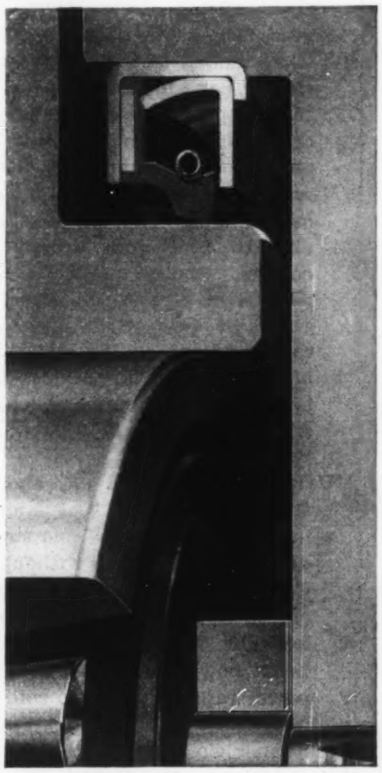
Fig. 1—Typical application where oil seal rotates with the mechanism.

The problem of adjusting spring tension so that zero leakage is achieved at full speed while at the same time keeping friction light when the machine is starting, could not be satisfactorily solved with any but the low torque synthetic seal. This problem was encountered in connection with the new adjustable-pitch propellers now being used on modern aircraft.

In such applications the oil seal diameters may run six, eight and ten inches. The seal press fits into the propeller and rotates with the propeller. Sealing lip contact is established with a stationary housing (see Fig. 1). Speeds may reach as much as 5,000 F. P. M.

Minimum contact, low torque SYNTECH* Sealing Member Design makes it practical to adjust tensioning far beyond normal.

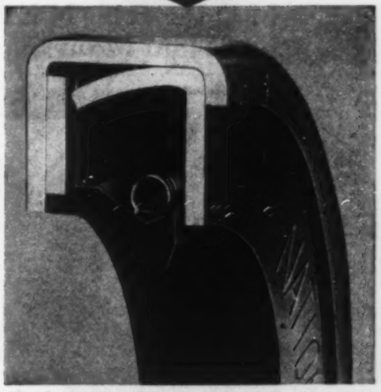
Fig. 2—Section of National Syntech rubber seal.

National 50,000-S Type Seals Solve the Problem

These problems are solved with regular design 50,000-S National spring-loaded Syntech oil seals. The basic design of these seals provides for almost "pin-point" contact between sealing lip and sealing surface (see Fig. 2). Under normal operation the spring tensioning can be very light. Thus with Syntech seals it is possible to achieve effective tensioning without causing excessive friction. At high speed, despite the action of centrifugal force, an effective seal is maintained.

The ability of National Syntech oil seals to withstand high speeds and provide zero leakage with light shaft contact made it possible to solve this problem. Perhaps you are encountering similar problems. For further information please contact the nearest National Oil Seal office.

**Syntech is the registered trademark for the National synthetic rubber compound.*

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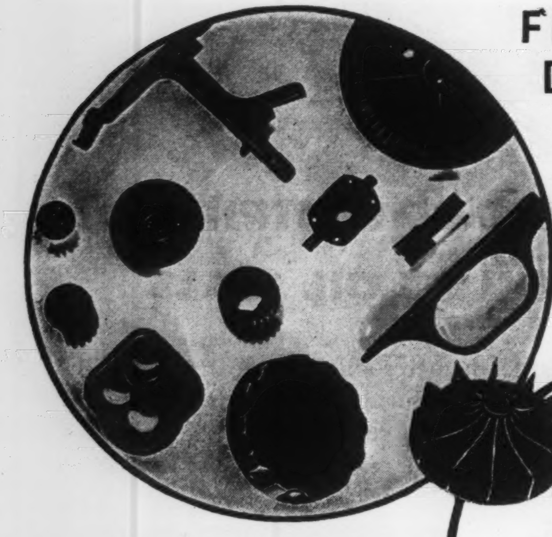

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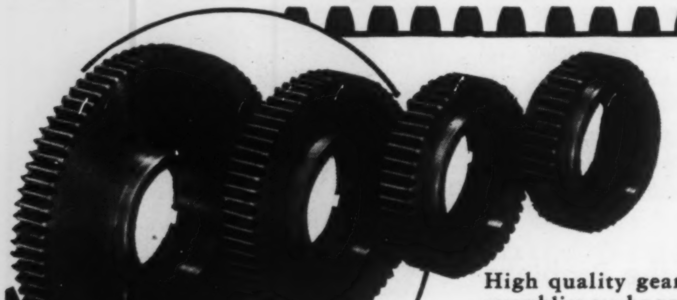

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from 0.0015 to 0.0841-in. Ram type hexagon turret has power and hand feed. Spindle speed ranges from 16 to 880 rpm in 12 steps. South Bend Lathe Works, South Bend, Ind.

ELECTRIC FURNACE. For sintering powdered metals, brazing, bright annealing, etc. Normal heat range, 1400 to 2500 F, with "flash" firing to 2750 F. Furnace is of manual pusher type for batch treatment on straight-line, 3-zone system. Doors equipped with automatic flame curtains preventing contamination of furnace atmosphere when doors are open. Adjustable silicon carbide doors provided between preheat, high-temperature and cooling sections. Pereny Equipment Co., Columbus, O.

VERTICAL SANDER. Weight, 5 lb without sanding pad. Speeds adjustable to 5000 rpm using throttle control. Choice of 7-in. backing pad, 4-in. grinding wheel with guard or 4-in. wire brush. Height to end of spindle, 8½ in. Direction of exhaust can be controlled. Safety throttle eliminates quick starts and stops. Aro Equipment Corp., Bryan, O.

UTILITY SHAPER. In 16 and 20-in. stroke sizes, for tool room and maintenance work. Table supported directly on cross rail without apron. Cutting speeds of 250 fpm possible on 10-in. stroke. Extra features available include improved tool lifter, power down-feed to head and power rapid-traverse to rail. Equipped with 3 or 5-hp drive. Cincinnati Shaper Co., Cincinnati, O.

ARC WELDER. For light gage welding in maintenance, repair or home work shops. Maximum output, 60 amps. Can also be used for joining strap, pipe tubing, etc., as well as for cutting metals, soldering, brazing and when used with a small rectifier, for battery charging. Operates from standard 110-volt light circuit fused for 30 amps. Weight, 50 lb. Lincoln Electric Co., Cleveland, O.

ARBOR PRESS. Air powered. Double-acting cylinder provides control of advance and retract strokes of ram. Operates on air line pressures to 175 psi, develops 20 times line pressure. Stroke length adjustable to 2½ in. Ram clearance adjustable from 1½ to 7 in. in 4 steps. Throat clearance, 5 in.; table size, 8 by 9 in. Bellows Co., Akron, O.

SHOP PRESSES. Capacities, 60 and 80 tons. For light-duty press requirements. Include pressure stroke of 13 in., lower bolsters supported by bearing blocks, and hand or power operation. Two-speed hydraulic hand pump with automatic shift

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Get a better score on *1*) production costs, *2*) quality, and *3*) time and labor savings by checking Bundyweld Tubing.

Bundyweld *and only Bundyweld* is double-walled from a single strip of metal. Copper-brazed at all points of wall contact, thin, extra-strong Bundyweld assures less leakage under pressure, less breakage under short-radius bends. It is readily fabricated, lightweight, and easy to handle.

Here are only a few of the industries which have made Bundyweld the standard for many of their tubing applications:

Automotive—fuel, hydraulic, vacuum, and brake lines.
Refrigeration—condenser, evaporator, and compressor tubing parts.
Range—supply lines, flash and pilot tubes.
Radiant heating—panel grid tubing.

Bundyweld for television antennas; beer coils of special Bundyweld Nickel; toy baby carriages, whistling gas-tank signals—these are just a few of the applications of Bundy Tubing that are making profits for their manufacturers.

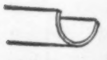
If you have a design or production problem, or a new idea for tubing, why not contact Bundy engineers to help you work it out? Just call or write: *Bundy Tubing Company, Detroit 14, Michigan.*

BUNDY TUBING

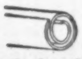
ENGINEERED TO YOUR EXPECTATIONS

* REG. U. S. PAT. OFF. ®

WHY BUNDYWELD IS BETTER TUBING

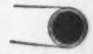


1 Bundyweld Tubing, made by a patented process, is entirely different from any other tubing. It starts as a single strip of basic metal, coated with a bonding metal.



2 This strip is continuously rolled twice laterally into tubular form. Walls of uniform thickness and concentricity are assured by close-tolerance, cold-rolled strip.

3 Next, a heating process fuses bonding metal to basic metal. Cooled, the double walls have become a strong ductile tube, free from scale, held to close dimensions.



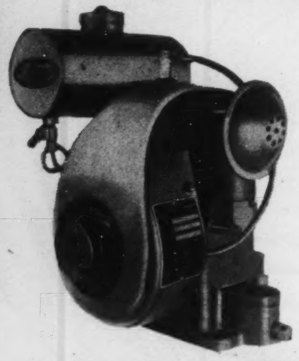
4 Bundyweld comes in standard sizes, up to ⅝" O.D., in steel (copper or tin coated), Monel or nickel. For tubing of other sizes or metals, call or write Bundy.

BUNDY TUBING DISTRIBUTORS AND REPRESENTATIVES

Cambridge 42, Mass.: Austin-Hastings Co., Inc., 226 Binney St. • *Chattanooga 2, Tenn.:* Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. *Chicago 32, Ill.:* Lapham-Hickey Co., 3333 W. 47th Place • *Elizabeth, New Jersey:* A. B. Murray Co., Inc., Post Office Box 476 • *Philadelphia 3, Penn.:* Rutan & Co., 404 Architects Bldg. • *San Francisco 10, Calif.:* Pacific Metals Co., Ltd., 3100 19th St. • *Spokane 6, Wash.:* Eagle Metals Co., E. 330 Trent Ave. • *Toronto 5, Ontario, Canada:* Alloy Metal Sales, Ltd., 881 Bay St.

BUNDYWELD NICKEL AND MONEL TUBING IS SOLD BY DISTRIBUTORS OF NICKEL AND NICKEL ALLOYS IN PRINCIPAL CITIES.

Now! A New Lightweight LAUSON Engine!



- Here's that famous Lauson dependability — now available in an engine weighing only 23 lbs!
- ¾ H. P. — the perfect portable power. 4-Cycle, Air-Cooled. Other models to 5 H. P.
- Instant starting — economical operation.
- Machined mounting pad on crankcase for direct mounting of pumps, generators, etc.

Dept. MD, The LAUSON Company, New Holstein, Wis.

LAUSON

In Canada:
Hart-Emerson Ltd.
Winnipeg, Canada

ENGINE BUILDERS FOR OVER 50 YEARS!

WHAT'S THE FINISHED COST?

In relation to the cost of machining this 18½-ton angle plate, a little difference one way or the other in the price of the casting itself is of small consequence. The chief consideration is the character of the casting—whether it will require the maximum or minimum of finishing.

If a sound, accurate casting costs more, it is worth more because of the savings in the machine shop. On the contrary, a distorted and defective casting entails so much extra finishing cost that it is expensive at a ridiculously low price.

Advance Castings are bought by customers who think in terms of the finished product. Yet they are keenly aware of casting prices and carefully check our quotations. They pay us only what they think Advance Castings are worth—and our business continues to grow.

If you are interested in custom castings that are really economical, we'd like to talk to you.

ADVANCE CASTINGS

THE ADVANCE FOUNDRY CO.
DAYTON 3, OHIO

STRENES METAL • ALLOY GRAY IRON • GRAY IRON

permits ram speed of $1\frac{1}{8}$-in. per stroke with 2-ton high-speed pressure on 60-ton model; ¾-in. travel with 3 tons on 80-ton model. Pump automatically shifts into high pressure on reaching 2 or 3 tons pressure. Rodgers Hydraulic Inc., Minneapolis, Minn.

Materials Handling

STRADDLE TRUCK EXTENSION SHOES. Increase possible length of palletized loads and eliminate need for special large skids. For handling oil drums or general cargo. Capacity, 40 drums weighing 10 tons. Hyster Co., Portland, Oreg.

ROLLER CONVEYOR. Aluminum or magnesium frame, plastic rollers. In 10-ft sections, each weighing 31 lb. Capacity, 500 lb distributed over 10-ft section. Rollers 2-in. diameter, 10 in. long; overall width of conveyor, $12\frac{7}{16}$-in. Alvey Conveyor Mfg. Co., St. Louis, Mo.

FORK LIFT TRUCK. Gas powered. Capacity, 2000 lb, with load center 24-in. from heel of forks. Has 36-in. wheelbase, with widened frame for better protection of wheels and providing for easier servicing. Additional weight on drive wheels caused by longer wheelbase increases traction. Truck climbs 15 per cent grades with full load. Clark Equipment Co., Industrial Trucks Div., Battle Creek, Mich.

ELECTRONIC COUNTER. For piling tin plate in exact quantities. Sheets counted photoelectrically as they pass on split conveyor. When predetermined count is reached, counter automatically operates deflector mechanism to start new pile. Counting rate, to 60,000 per minute. Potter Instrument Co., Flushing, N. Y.

DIE HANDLING TRUCK. Capacity, 16,000 lb. Platform size, 48 by 57 in. Hydraulically elevated from 24 in. to max height of 38 in. using 4 hydraulic hoists operating against toggle levers and powered by 2-speed hand pump. Roller top consisting of 5 rows of rollers can be removed to give 3 in. lower table. Hand winch used to draw dies on table is geared at 96 to 1 ratio. Truck mounted on 10-in. ball bearing wheels. Lyon-Raymond Corp., Greene, N. Y.

CRATE HANDLING ATTACHMENT. For electric trucks. Clamping device grips end slats of fragile wooden crates, such as refrigerator boxes, for lifting, carrying and loading. Sideshifting device permits load to be shifted 4 in. either way from center position to facilitate load spotting for operator. Clamping arms actuated by hydraulic pressure from truck's hydraulic system;

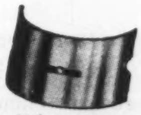
FINE BEARING QUALITY MEANS *finer performance!*

A precision sleeve bearing looks pretty simple yet it is a complex structure of several metals having at least 27 separate and distinct dimensions.

One type of Federal-Mogul sintered copper-lead main bearing requires 25 separate manufacturing operations, a total of 84 measurement checks and 24 temperature, analysis and special tests.

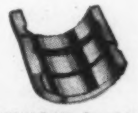
Our Quality Control group checks every step in sleeve bearing production, from raw material to finished product to make sure that it is right and meets your most exacting specifications.

For the best in engine bearing service consult our engineers.



HIGH SPEED, high temperature, automotive type bearings available in many combinations.

SPEED & LOAD bearings for pumps, compressors, industrial electric motors and similar uses.



HEAVY LOAD for big Diesels, power plants, etc.—bearings up to 27½" O.D., steel and bronze back.

BRONZE PARTS in many shapes, sizes; thrust washers, bushings; for many types of applications.

1899 • Fifty Years of Continuous Bearing Experience • 1949

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13
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NON-FERROUS AND STAINLESS STEEL
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2 Resistance to High Temperatures
3 Non-Magnetic
4 Non-Sparking
5 Re-Usable
6 Attractive Appearance
7 Easy to Clean
8 High Strength
9 Long Life
10 Lower Ultimate Cost
11 Resistance to Fatigue
12 Easy to Plate or Finish
13 Resistance to Abrasion and Wear

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control is by pushbutton from operator's position. Automatic Transportation Co., Chicago, Ill.

Plant Equipment

CRANE SCALES. For measurement of loads being handled by cranes or for other force or load measuring applications. Capacities of 3 models, 0 to 30,000 lb. Hydraulic cell converts force into pressure and load is read on pressure type indicator. Hook and eyebolt swivel mounted. Dial sizes, 8½, 12 and 16-in. diameters. Guaranteed accuracy within 1 per cent of reading or 0.2 per cent of capacity. A. H. Emery Co., Stamford, Conn.

DIESEL-ELECTRIC PLANT. Portable. Capacity, 5 kw. Powered by opposed, 2-cylinder, air-cooled engine. Weight, 725 lb less starting batteries. Dimensions; 38¾-in. long, 30¼-in. wide, and 26⅛-in. high. Available in 50 or 60-cycle models. Generator directly connected to crankshaft; saturated field generator is self-regulating. Remote control stations can be installed within 250 ft of unit. D. W. Onan & Sons Inc., Minneapolis, Minn.

STANDBY POWER PLANT. Capacities, 5000 watts to 200 kw, 60 cycle at 1200, 900 and 720 rpm. Also available in frequencies from 25 to 400 cycles. Powered by 1, 2 and 4 cylinder, air-cooled engines, requiring no radiator or antifreeze solutions. Equipped with high tension magnetos, permitting easy hand cranking and eliminating need for starting batteries. With or without automatic voltage regulators. Kato Engineering Co., Mankato, Minn.

DIE CUSHIONS. Self-contained, pneumatic and hydropneumatic types for power presses. In standard sizes from 4 to 28-in. diameter in single piston type; from 10 to 30-in. diameter in double piston type. Baker Bros. Inc., Toledo, O.

GAS BURNER. For boilers. Capacities, 2½ and 5 million Btu input, or about 50 and 100 developed boiler hp. All combustion air furnished through burner by blower, giving complete fuel-air ratio control for best efficiency. Complete package units easily installed; unit with modulating control is entirely automatic. North American Manufacturing Co., Cleveland, O.

Processing

TOBACCO PROCESSING MACHINE. Automatically removes stem from tobacco leaf, separates loose stems from strips. Eliminates dust, sand and other foreign matter. Automatically loaded and discharged, machine handles from 1000 to 1800 lb per hour. American Machine &

SHOCK AND VIBRATION NEWS
BY BARRY

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To preserve the high standard of smooth, silent riding achieved in modern transportation . . . to isolate fan motor vibration . . . and to protect the unit from accidental shock, Sturtevant specifies BARRYMOUNTS.

Experience has proved to Sturtevant that, in numerous railway and bus applications, BARRYMOUNTS provide uniform dependability of sound isolation and protection from shock and vibration.

Whatever your vibration problem . . . whether it involves fans, motors, heavy machinery, transformers, punch presses, or delicate instruments . . . BARRY experience and consulting engineering facilities offer a sure solution. Our free catalog lists stock mountings; for special information, call our nearest office or write to

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Farrel Speed Reducers

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Please send me, without cost or obligation, a copy of Bulletin 449, "Farrel Speed Reducers".

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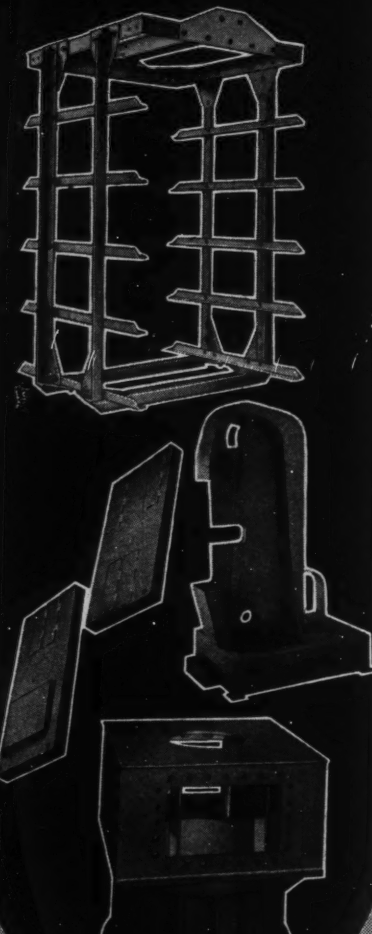
Littleford facilities and skilled workmen are qualified to fabricate any product of plate or sheet metal that may apply to your production.

Littleford weldments have long been known for uniformity, accuracy, strength and adaptability. Rigid demands of manufacturing plants, design engineers, have been met easily and without exception.

If you have a weldment problem send blueprints to Littleford, see how experience can insure economies in plate and sheet metal fabrication.



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LITTLEFORD BROS., INC.
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Foundry Co., New York, N. Y.

SAMPLER. Takes periodic cuts or samples from stream of wet or dry moving material. For mining, stone products, ceramics, chemical and allied process industries. Automatic unit can be set to operate periodically at intervals from 5 to 60 minutes. Hardinge Co. Inc., York, Pa.

Testing and Inspection

CONTINUOUS MEASURING GAGE. Automatically controls thickness of plastic coating deposited on copper electrical wire. Transmits electrical impulses when dimensions are out of tolerance. Thickness measured using 2 rollers in contact with wire. Continuous thickness recorder can be installed. Federal Products Corp., Providence, R. I.

SPRING ANALYZER. Hydraulically operated using hand pump. Measures rate of compression springs ½ to 6 in. long, tension springs 1 to 22 in. long. Handles springs to 3-in. diameters. Rate readings given in lb from 0 to 300 lb. Permits field testing of springs, matching and balancing of springs in sets, and experimental testing. Storm-Vulcan Inc., Dallas, Tex.

Transportation

BICYCLE ENGINE. Twin-cylinder, 2-cycle unit rated at 3¼-hp. Includes automotive type, multiple dry-disk clutch, combination fuel tank and utility compartment, Eisemann magneto and twist-grip controls. Will not overheat when idling; compression release contributes to easy starting and rapid deceleration. Jack & Heintz Precision Industries Inc., Cleveland, O.

Woodworking

PORTABLE ELECTRIC SAW. Uses 8½-in. blade powered by 2⅛-hp motor. Cuts 2⅛-in. plank at 45 degrees or 3-in. straight cut. Aluminum alloy base measures 6¾ by 15⅜-in., with beveled edges for smooth operation. Free blade speed, 5300 rpm. Includes telescoping blade guard, enclosed trigger type safety switch. Weight, 19½-lb. Frame is cast magnesium alloy. American Floor Surfacing Machine Co., Toledo, O.

ELECTRIC SAW. Medium-weight, high-powered, one-handed saw for general work. Has 8-in. blade, adjustable for any depth to 2¾-in., tilts to 45 degree angle. Fan draws air through motor, discharges in front to keep cutting line clear. Saw idle speed, 7000 rpm; load speed, 4500 rpm. Weight, 17 lb. Porter-Cable Machine Co., Syracuse, N. Y.

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Springs, Wire Forms, Stampings

pick and shovel days are over

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Bull-dozers and steam shovels ended pick and shovel methods in earth moving. So modern strip mill facilities banished pick and shovel techniques in rolling stainless sheet and strip. Climaxing this progress, CRUCIBLE, a *specialty steel* producer for half a century, has built an $18,000,000 mill at Midland Works *specifically* for rolling stainless steel—the *first mill* that has ever been built to take complete advantage of the *best* in stainless rolling practice.

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Moreover, with Trent Tube Co. joining the organization you can now turn to CRUCIBLE for *every* type of stainless—sheets, plates, strip, bars, tubing, forgings, wire and castings. Data sheets are available for all grades. Your inquiries will have prompt attention.

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DO YOU HAVE this HANDBOOK?

We are referring to the 176-page book labeled "The Tool Steels of Allegheny Ludlum." It covers LXX, DBL-2, Super Panther, Deward, Saratoga, Huron, Ontario, Sagamore, Potomac, Pompton, Seminole, Utica, and other famous A-L grades. *Get your copy.*

ADDRESS DEPT. MD-78

That block or bar or rod of quality tool steel you received from Allegheny Ludlum . . . had to run the gamut of our vigilance committee right up to shipment time. You probably weren't here to watch the technically planned mill procedure, the laboratory controls, and the inspections—but you can quickly appreciate the value of our dozen or more quality safeguards, once the steel goes into service.

Consider, for example, the supersonic reflectoscope. It's uncanny how that ferrets out any internal flaw.

This daily ritual of checking, testing, and inspecting at the various stages of production means that, in effect, we are operating our own "Bureau of Standards." By thus insuring quality, we protect you—the customer. You get better results.

For sound, clean, tool and die steels—uniformly accurate in analysis, structure, hardness, and size—call A-L.

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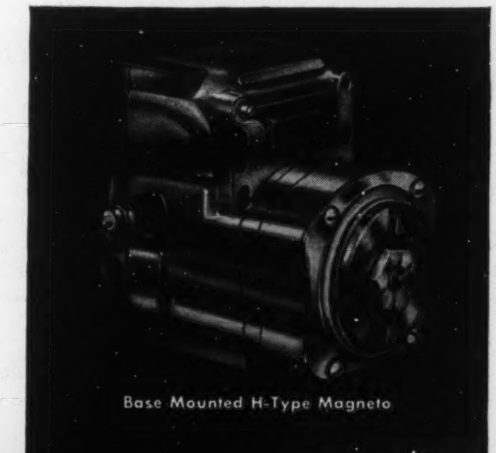
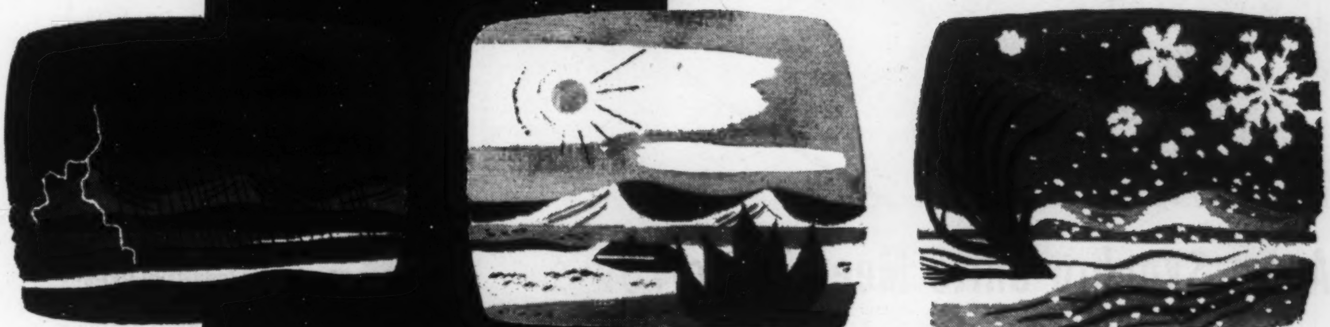
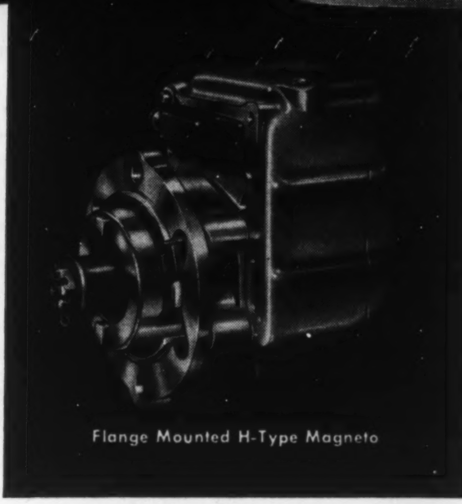
H TYPE MAGNETOS...


Base Mounted H-Type Magneto




Flange Mounted H-Type Magneto

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Dependability isn't something seasonal—it's a year around proposition and there are no short cuts in building it into engines. Specifying component parts you know will stand up under all operating conditions is the *only* answer! Ignitionwise, no magneto of its type will out-perform or out-last the Bendix-Scintilla* H Magneto. Our long experience in building ignition equipment for the vast majority of aircraft engines is reflected in this magneto for one-cylinder engines. Include the Bendix-Scintilla H-Type Magneto in your specifications. For further details, see your distributor or write the factory direct.

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- **Waterproof coil**
- **Waterproof, high-tension outlet**
- **Higher voltage at starting speeds**
- **Constant spark over entire speed range**
- **Equipped with impulse coupling**
- **Compact and sturdy construction**

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AVIATION CORPORATION

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SIDNEY, NEW YORK

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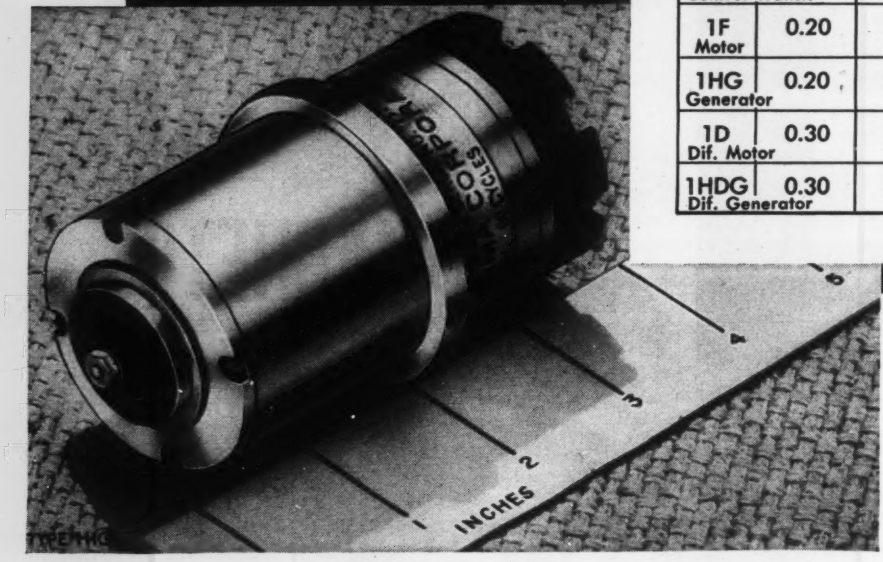
To Top Flight Development, Design and Instrumentation Engineers:

This table gives the essential characteristics of Arma Synchro Units. The information may suggest applications of these components to your designs.

Type	Open Circuit Primary Excitation		Torque Gradient oz. in/deg.	Rotor Inertia (oz. in.^{2})	Weight (Approx.)
	Amps.	Watts			
1CT Control Transf.	0.03	0.5	—	0.36	1 lb. 5 oz.
1F Motor	0.20	3.5	0.10	0.52	1 lb. 5 oz.
1HG Generator	0.20	3.5	0.10	0.52	1 lb. 4 oz.
1D Dif. Motor	0.30	7.4	0.04	0.54	1 lb. 4 oz.
1HDG Dif. Generator	0.30	7.4	0.04	0.54	1 lb. 4 oz.



Arma Synchro Units Meet *Tomorrow's* Industrial Instrumentation Needs

These five Arma Synchro Units are designed and built to operate *accurately, with minimum servicing.* The standards of accuracy, and resistance to vibration, shock and temperature are so high that they would appall most commercial generator and motor designers.

New

As components of some of the most precise control, computing and servo systems ever conceived, these Arma Synchro Units were previously restricted so that many engineers have never had an opportunity to consider applications of them to instrumentation and design problems.

Accurate

Combinations of these synchro units will transmit with high accuracy, rotary motion and position. They will indicate the sum or difference of position or rotation. Through an Arma control transformer, the varying voltages of a synchro system can be linked to electronic means of controlling large amounts of power.

In simple, "flexible-shaft" arrangements, Arma Synchro Systems are accurate to within 0.5 degree. However, accuracies of higher order are readily obtainable with multi-speed synchro systems such as that used on the 200 inch telescope at Mt. Palomar.

More Advantages of Arma Synchros

Conservative Electrical Design. Low power consumption, low temperature rise, large creepage distances and air gaps, 1,500 volt insulation, low loss laminations.

Power Supply 115 volt, Single-Phase, 60 cycle.

Convenient Accurate Mounting through concentric flanges.

Accurately - Ground, True - Running shaft extensions, with keyed tapers or clamps.

Bearings, (*Free-Rotor Units*), are Arma design, already used in over 1,000,000 units.

New "Tools" for Industrial Designers

It may pay you to re-examine, in the light of these high-accuracy Arma Synchros, instrumentation projects once abandoned because of the limitations of available components.

Use These Other Arma Components, Too

Tachometer-type Induction Generators for high performance in servo systems; two-phase Induction Motors for servo-mechanisms and control devices; Electrical Resolvers* for solving problems involving triangles, coordinates and vectors; high-precision Mechanical Differentials for computer applications.

Arma follows through to Realities

For over 30 years Arma Corporation has been quietly taking on (under wraps) one complex development and design problem after another for the U. S. military establishments—problems concerned with instrumentation. When Arma *finishes,* the problem is not only solved but the actual equipment to do the job, ***built.***

You are invited to request whatever information you may need to explore the possibilities of making use of any Arma product which has been released from security restrictions.

ARMA CORPORATION
254 36th STREET, BROOKLYN 32, N. Y.
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ARMA PRODUCTS RELEASED FOR PRIVATE INDUSTRY

ARMA ELECTRICAL RESOLVERS* • ARMA SYNCHROS • ARMA INDUCTION MOTORS • ARMA INDUCTION GENERATORS • ARMA MECHANICAL DIFFERENTIALS • ARMA ALTERNATING VOLTAGE COMPARATOR • COMPUTING MECHANISMS • INDUSTRIAL CONTROLS • STABILIZATION DEVICES • NAVIGATIONAL EQUIPMENT • LIMITRON AUTOMATIC INSPECTION SYSTEM

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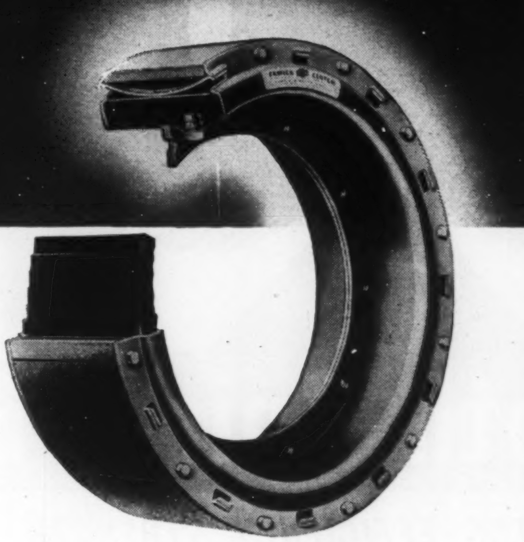
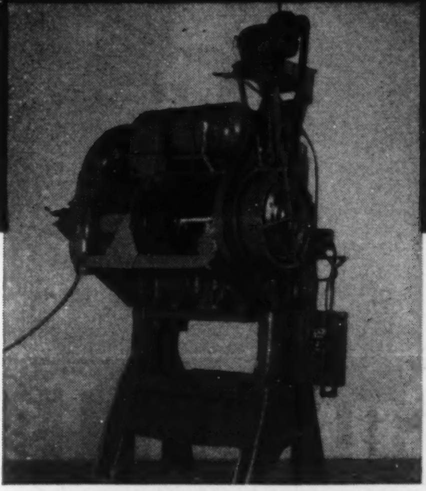
FAWICK-EQUIPPED MACHINES

do More Work at Less Cost



Fawick Air-Ring Clutch or Brake Type E

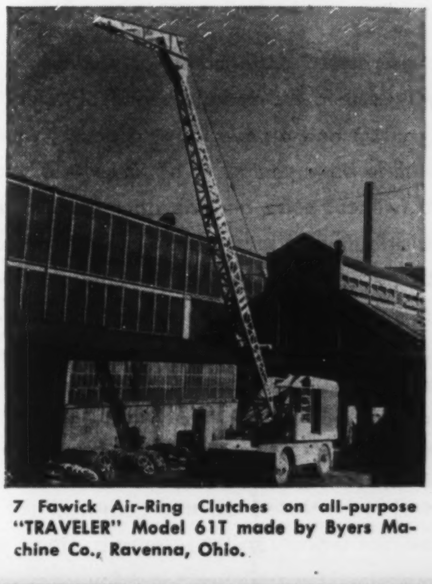


Fawick Airflex Clutch and Fawick Air-Ring Brake used on a Toledo 92½ B Press rebuilt by Anbaco Corp., Niagara Falls, N. Y.

Time-wasting clutch adjustment down time is practically eliminated on Fawick-equipped machines. The moving parts of this Fawick Clutch—the rubber-and-fabric pneumatic tube and the friction shoe assemblies—adjust automatically and compensate for wear.

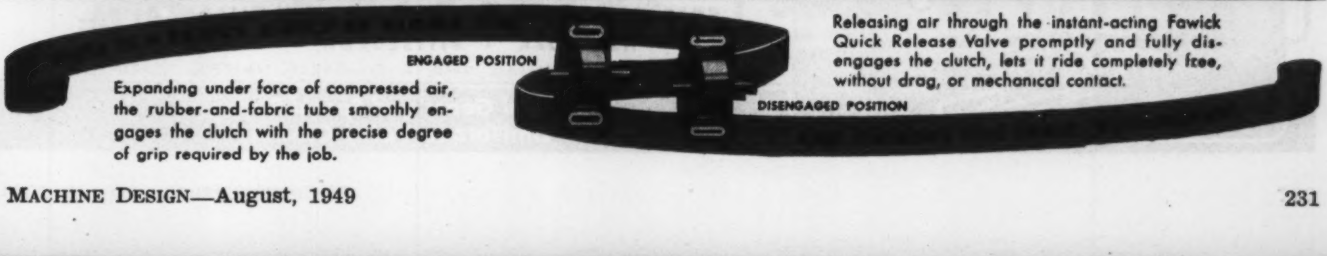
The smooth engagement action of this Fawick Clutch eliminates sudden shock loads which damage machinery. Controlled torque starting can be obtained with a simple modulating air valve. This type Fawick Clutch is ideally suited to continuous slip applications.

For specific recommendations for your machines, write to our Engineering Department today. Address Dept. MD.



7 Fawick Air-Ring Clutches on all-purpose "TRAVELER" Model 61T made by Byers Machine Co., Ravenna, Ohio.

FAWICK *Airflex* CO., INC.
9919 CLINTON ROAD CLEVELAND 11, OHIO



Expanding under force of compressed air, the rubber-and-fabric tube smoothly engages the clutch with the precise degree of grip required by the job.

Releasing air through the instant-acting Fawick Quick Release Valve promptly and fully disengages the clutch, lets it ride completely free, without drag, or mechanical contact.

. . . the *Ideal* combination for power transmission between shafts at any angle and any speed

PHILLIE
GEAR

Curved Tooth Spiral Bevels

—FOR SMOOTHNESS, QUIETNESS, EFFICIENCY, STRENGTH AND DURABILITY

The *unsurpassed performance* of Curved Tooth Spiral Bevels and Hypoids, is largely due to the curvature and obliquity of teeth—assuring continuous pitch line contact and an overlapping action, which always allows at least *two pairs of teeth to be in contact at all times* — a smooth transfer of load from tooth to tooth (without noise and vibration) and *increased load carrying capacity*, due to the distribution of load over a greater number of teeth.

Large Spiral-Bevels and Hypoids, when specified, have their teeth (only) hardened on our own Surface Hardening Machines—while smaller gears may be hardened by the induction, straight heat-treating, or case-hardening methods.

NOTE: *Hypoid gears* are similar to Spiral-Bevel gears —excepting that they have the pinion axis *above* or *below* the center of the gear axis—and, Hypoids run even *more accurately* and *smoothly* than Spiral-Bevels.

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Gears

Send for the "Gear Book" and use your Business Letterhead when writing.

Philadelphia Gear Works, INC.

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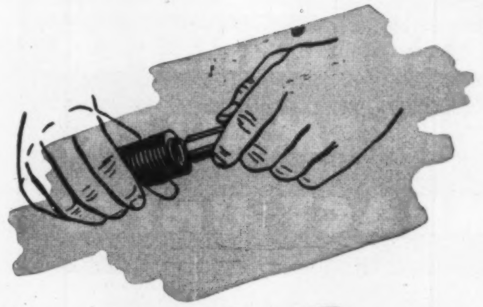
IN CANADA: WILLIAM AND J. G. GREEY LIMITED, TORONTO

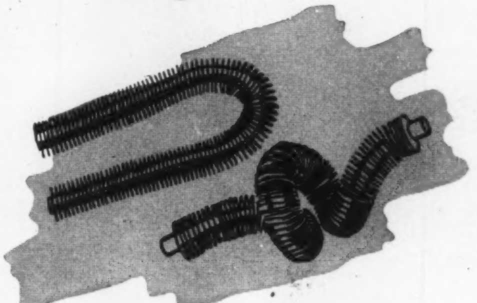
Industrial Gears and Speed Reducers
LimiTorque Valve Controls

You'll Want to Know These *Important Facts* about WOLVERINE TRUFIN



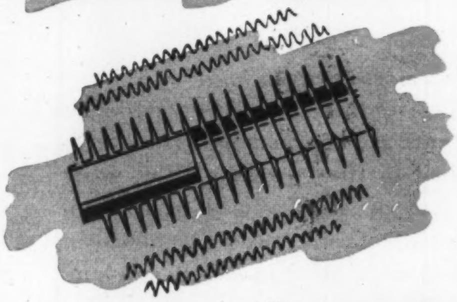
How Easy Connections are Made!

It is sometimes necessary when using finned tube to strip the fins from the ends of the tube for a pre-determined length prior to fabrication. Not so with Wolverine Trufin. This integral finned tube, held to inside diameter specifications, can be fabricated completely, and then ends can be sawed to length and inserted connections can be made by brazing any standard tube into the finned tube. Stripping of the ends is eliminated and savings in time and materials are effected.



How Easy Trufin can be Fabricated!

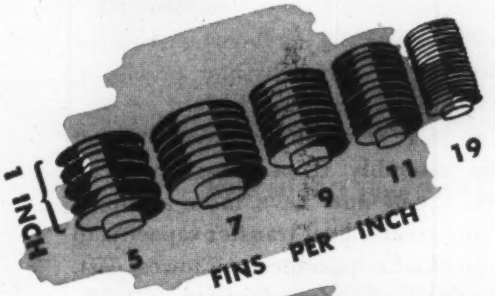
This integral finned tube can be formed into coils, hairpins, and other shapes much easier than plain tube since the fins act as a support to the exterior. Thus, shorter bends can be made without the use of a mandrel inside and support blocks on the outside.



How Much Endurance Trufin Has!

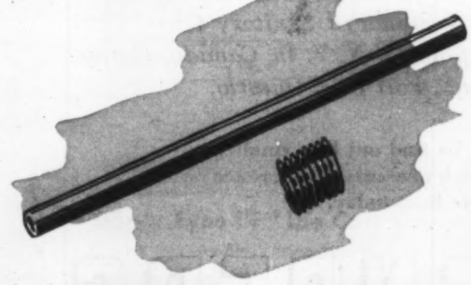
It is suitable for nearly all kinds of heat transfer work—heaters, coolers, interchangers, condensers, and many other applications. Vibration does not deteriorate fin efficiency.

Since the fins are integral with the tube itself, it cannot be impaired as easily as other types of finned tube by corrosive conditions.



How Many Sizes and Alloys!

Trufin can be had in 5, 7, 9 and 11 fins per inch in inside diameters ⅛" to 1". It is also available in 19 fins per inch (held to root diameter specifications) for use in shell and tube condensers. Alloys (in 19 fins per inch) to meet most popular demands are available.



How Much It Multiplies Surface Area!

The equivalent outside surface area of a nineteen-inch length of plain tube, ⅝" diameter, for instance, can be obtained in just one inch length of Trufin of the same diameter. That's compactness!

Let us send you our latest literature that tells more about Trufin—the integral finned tube—and its many outstanding performance values.

WOLVERINE TUBE DIVISION
CALUMET AND HECLA CONSOLIDATED COPPER COMPANY
INCORPORATED
MANUFACTURERS OF SEAMLESS NON-FERROUS TUBING
1433 CENTRAL AVENUE, DETROIT 9, MICHIGAN

Continuing Thermal Research

NOW BRINGS YOU

GREATER HEAT TRANSFER CAPACITIES IN SMALLER, MORE COMPACT UNITS

OUT of the engineering department and research laboratory at Ross comes a steady flow of new manufacturing techniques and design improvements achieving continually higher levels of heat transfer efficiency and lower levels of cost per B. T. U.

Already widely known to primary equipment manufacturers and users are the tradition-shattering developments of the now famous Ross "BCF" line of exchangers. Now, of equal importance to practically every industry, comes news of the design changes to another of industry's favorites, the long established "CP" Exchanger — *another direct result of recent conclusions reached by continuing Ross thermal research.*

Having successfully accomplished the means of "cutting to the bone" ineffective areas, by-passing, eddies and excessive pressure drops, Ross now provides in the various sizes comprising the "CP" Exchanger line, *a greater heat transfer surface in a smaller, more compact unit.*

. . . and backing up these noteworthy performance developments are new manufacturing techniques as applied to the customary Ross mass production system of standardized parts manufacture. Closest practicable clearances between tubes and baffle holes, baffles and shell, and bundle and shell—*absolutely vital to complete, fully effective use of heat transfer surface*—are consistently and uniformly produced by new, precision, mass quantity manufacturing methods.

So, added to "CP" Exchangers' greatest asset — the custom assembly from mass produced standard parts — you now have more compact units embodying greater heat transfer capacity, to meet your individual requirements at lowest cost.

Ross Heater & Mfg. Co., Inc., Division of American Radiator & Standard Sanitary Corp., 1429 West Ave., Buffalo 13, N. Y. In Canada, Horton Steel Works, Ltd., Fort Erie, Ontario.

★ **DATA BACKS UP ALL CLAIMS: To find out how smaller "CP" clearances can make a high percentage difference in your heat transfer costs, write Ross today.**

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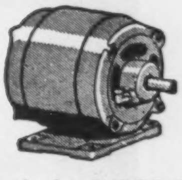
NEW MICRO Precision Switch

rating — 1½ Horsepower Motor at 230 Volts a-c.



Basic Switch
UND. LAB. INC. INSP.
MICRO Type "F"
Housing for Type "A"
Basic Switch
MICRO MS SWITCH
CAT. NO.
U.S.A.
UND. LAB. INC. INSP.

In the new Type "A" Switch, MICRO SWITCH offers a small, lightweight, accurate switch to handle the high current inrush required in the operation of solenoids, motors and tungsten lamps.

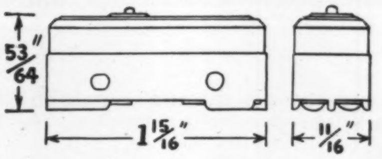
The MICRO Type "A" Switch is listed by Underwriters' Laboratories for 1½ H.P. motor, 230 volts a-c; ¾ H.P. motor, 115 volts a-c; 20 amperes, 125, 250 or 460 volts a-c; tungsten lamp, 10 amperes, 125 volts a-c. Rated for 75 amperes inrush capacity to 460 volts a-c.

If your design requires a small precise control switch which must take high current inrush throughout a long life . . . with no danger of welding or sticking . . . be sure you have all the facts on this new MICRO Type "A" Switch.

If your design calls for any kind of a small precision switch, MICRO SWITCH representatives can select from over 3900 variations of switches the one best suited to your needs. Call or write a MICRO SWITCH engineer at one of the offices listed below.

MICRO . . . first name in precision switches

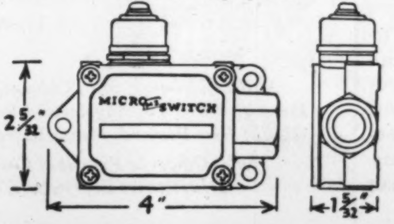
New MICRO Type "A" Switch


53/64"
1 15/16"
11/16"

This small switch will handle a 1½ H.P. motor at 230 volts a-c. It is available with five different types of actuators.

Sturdy Type "F" Die Cast Housing

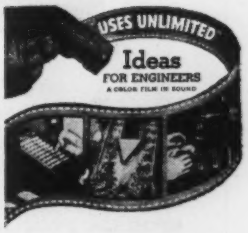
Ample Wiring Space.


MICRO MS SWITCH
2 5/32"
4"
1 5/32"

This MICRO Type "F" die cast housing is designed for the high capacity Type "A" Switch. The synthetic rubber seal boot covers the operating plunger and resists the entrance of oil, moisture, dust, etc. Available in right and left hand designs.

"USES UNLIMITED"

A dramatic MICRO SWITCH 16 mm. sound motion picture in color, is available to industrial groups, training classes, schools and colleges. Running time, 35 minutes.


USES UNLIMITED
Ideas
FOR ENGINEERS
A COLOR FILM IN SOUND

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MICRO SWITCH

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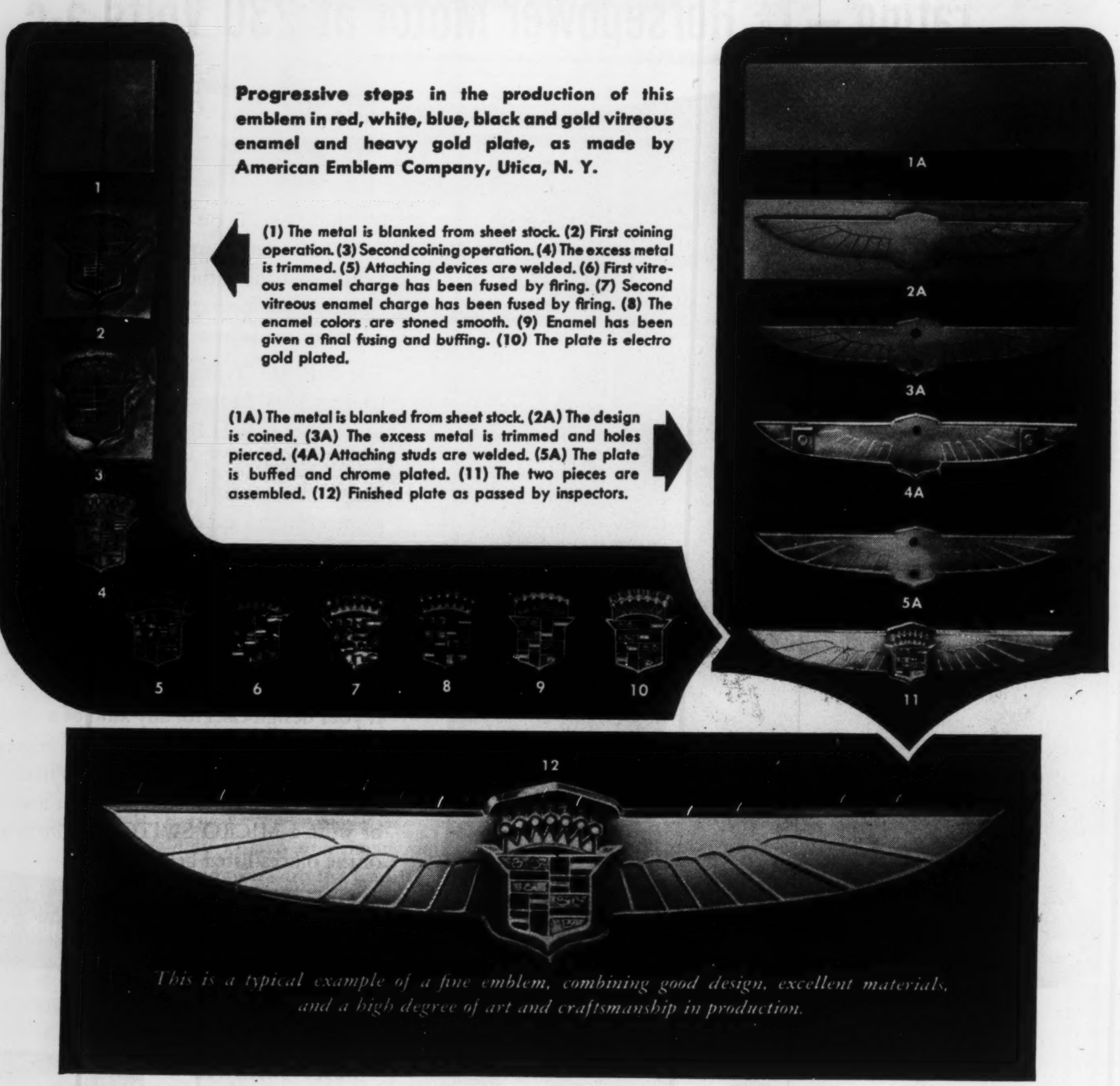
How the base metal protects the finish



Progressive steps in the production of this emblem in red, white, blue, black and gold vitreous enamel and heavy gold plate, as made by American Emblem Company, Utica, N. Y.

(1) The metal is blanked from sheet stock. (2) First coining operation. (3) Second coining operation. (4) The excess metal is trimmed. (5) Attaching devices are welded. (6) First vitreous enamel charge has been fused by firing. (7) Second vitreous enamel charge has been fused by firing. (8) The enamel colors are stoned smooth. (9) Enamel has been given a final fusing and buffing. (10) The plate is electro gold plated.

(1A) The metal is blanked from sheet stock. (2A) The design is coined. (3A) The excess metal is trimmed and holes pierced. (4A) Attaching studs are welded. (5A) The plate is buffed and chrome plated. (11) The two pieces are assembled. (12) Finished plate as passed by inspectors.

This is a typical example of a fine emblem, combining good design, excellent materials, and a high degree of art and craftsmanship in production.

It is almost always the case, though unsuspected by the general public, that the material to which a finish is applied has a definite influence upon the perfection and durability of that finish. For example, products that are nickel or chromium plated stand up better if the base metal is non-rusting, as is copper and brass. To take another example, look at vitreous-enameled emblems, used as trade-marks, name plates, medals, lapel pins, insignia, and so on. Most of these emblems have a copper alloy as the base metal; only that, or gold or silver, can be used.

These emblems owe their beautiful and permanent colors to silicate pastes and powders, inlaid by skilled artisans, and twice fused in a furnace at a temperature of about 1500° F. This temperature sets high standards for the underlying metal which must not warp, nor "bubble up" into the enamel. Thus visible beauty for which so much creative skill is required, depends in part on the invisible metal underneath. Revere, which takes great pains to maintain the strict standards of its alloys, is proud to meet the high requirements of American Emblem and other companies in this field . . . Perhaps Revere can help you by supplying exactly what you require to protect the finish and durability of your product.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801
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Flash-Butt Welded Rings and Bands, manufactured by American Welding "Controlled Technique" give you superior products at low cost. We flash-butt weld both ferrous and non-ferrous metals. Send us your prints, specifications and quantities for prompt quotations.

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Ohio Stock Gears save money because they eliminate the extra cost of special orders. They save time because they cut out delivery waits. They are ready for you at the nearest Ohio Distributor. They banish costly down-time when replacements are necessary.

You can get Ohio Stock Gears to fit your needs in spur, bevel, helical, worm and worm gear types in 24 to 3 diametral pitch and in miter type from 24 to 4 diametral pitch.

See for yourself how much you can save with Ohio Stock Gears. Get in touch with the nearest distributor today.

ESTABLISHED 1915

THE OHIO GEAR COMPANY

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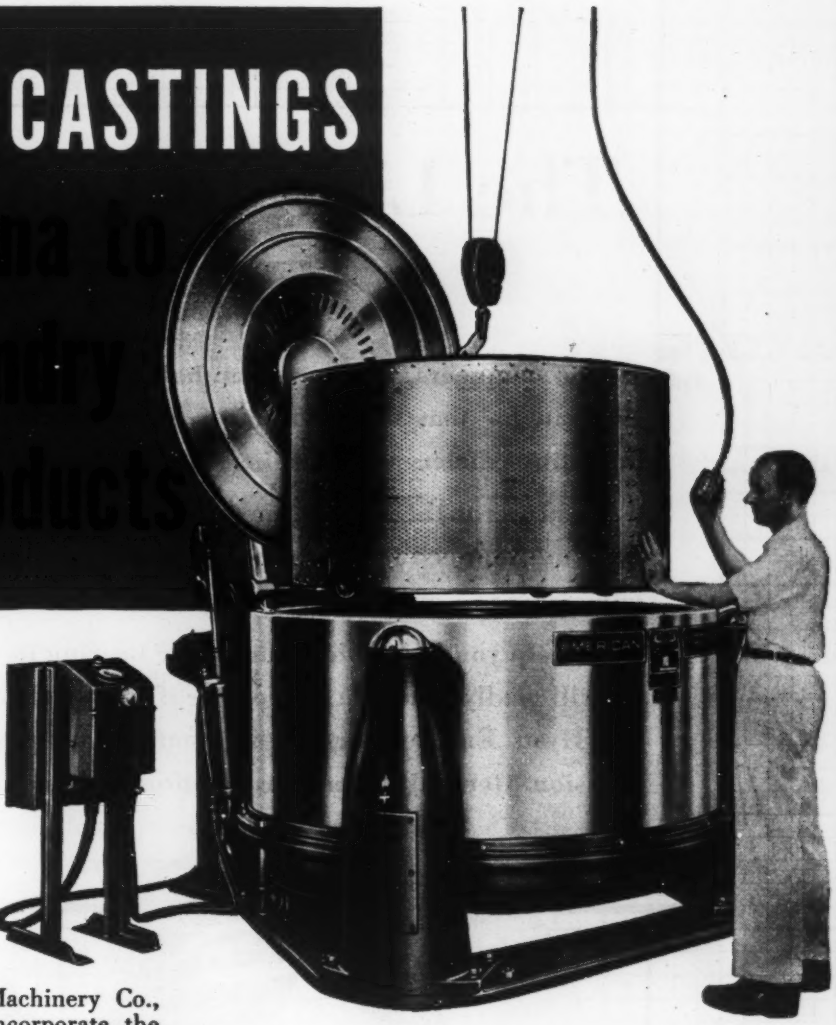
OHIO GEARS

MEEHANITE® CASTINGS

Provide Stamina to American Laundry Machinery Products



ALL UNITS built by American Laundry Machinery Co., Rochester, N. Y., are designed to incorporate the "better property" characteristics of Meehanite castings. The American Notrux Extractor illustrated is a good example offering users increased efficiency and a smooth, high-speed machine which will provide long, uninterrupted service.

Typical of the important Meehanite parts are the following:

1. Curb and Floor Base.
2. Legs.
3. Motor Bracket.
4. Basket Comb.
5. Sheave and Brake Drum.
6. Bearing Housings.

The variety of these parts and their important functions are indicative of proper design analysis and the recognition that only through the assurance of quality castings can all service requirements be met.

Your equipment can take advantage of the uniformity and dependability built into Meehanite castings.

For further information write for the Meehanite Handbook, 67 pages of important engineering data, to any of the foundries listed.

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The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
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Barnett Foundry & Machine Co.	Irvington, New Jersey
H. W. Butterworth & Sons Co.	Bethayres, Pennsylvania
Continental Gin Co.	Birmingham, Alabama
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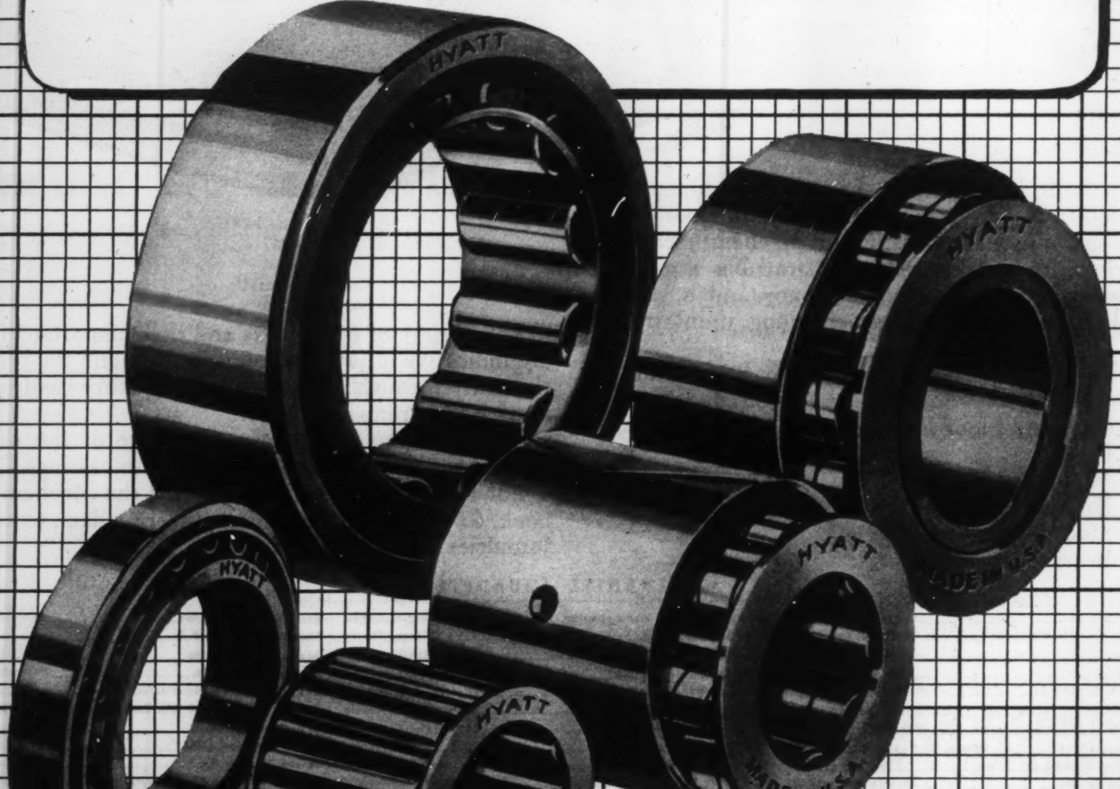
To help you locate the right roller bearing to fit your job precisely we will gladly send you catalogs or if you wish to consult a member of the Hyatt Engineering Service staff—just write to Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.



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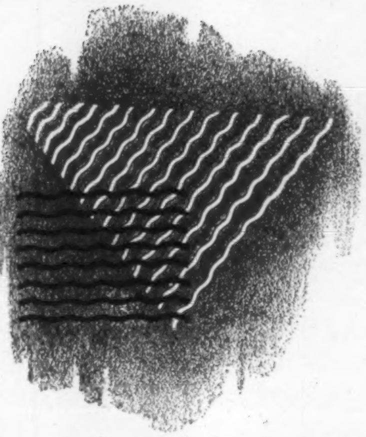
3 *places you can* PUT ON THE HEAT

with General Electric *Calrod*★ Heaters



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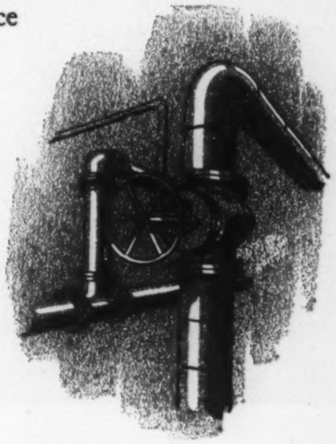
For practically any process requiring heated air . . . baking, drying, curing, warming, ripening, softening, etc. . . . there is a suitable Calrod heater . . . fin-Calrod heaters for forced convection with rapid heat transfer; Calrod tubular heaters for high-temperature, low-air-flow operation where space is limited; strip heaters for relatively low temperatures with natural convection.



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G-E heating cable will keep viscous liquids free-flowing and water solutions from freezing during cold weather. For pipelines handling materials which require high temperatures, G-E Calrod tubular heaters are a "natural."

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For standard tinning, babbitting, lead molding and soldering pots, *put the heat right where it is wanted* . . . in the metal for maximum heating efficiency and cooler working conditions with G-E Calrod cast-in "over-the-side" and "through-the-side" immersion heaters . . . in a wide variety of shapes and sizes.

★Reg. U. S. Pat. Off.

BEFORE you design your equipment or machinery . . . before you convert existing installations . . . be sure to consult a G-E Industrial Heating Specialist. His recommendations may pay you real dividends in terms of more efficient heating and better designs.

And be sure to see the latest slide film in the *MORE POWER TO AMERICA* series, "Heat—Where You Want It." It will show you exactly where and how you can build-in electric heat for better products and better designs.

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It takes 38,636 tough, accurate fasteners of high tensile strength — to match the stress and strain on the framing members of a diesel pulling heavy freight loads.

More than 2,300 bolts . . . 13,800 nuts . . . 21,700 screws . . . 800 rivets furnish the forces that hold modern 4 unit diesel assemblies together.

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To attain *T*rue *F*astener *E*conomy —save assembly time, eliminate or reduce plant inspection, and get the maximum holding power per dollar of fastener cost with a dependable quality fastener. *T*rue *F*astener *E*conomy contributes to the kind of production savings that puts more and more diesels on U. S. tracks every year. It is this type of contribution to major American industries that explains why — for over 104 years — RB&W has been *making strong the things that make America strong.*

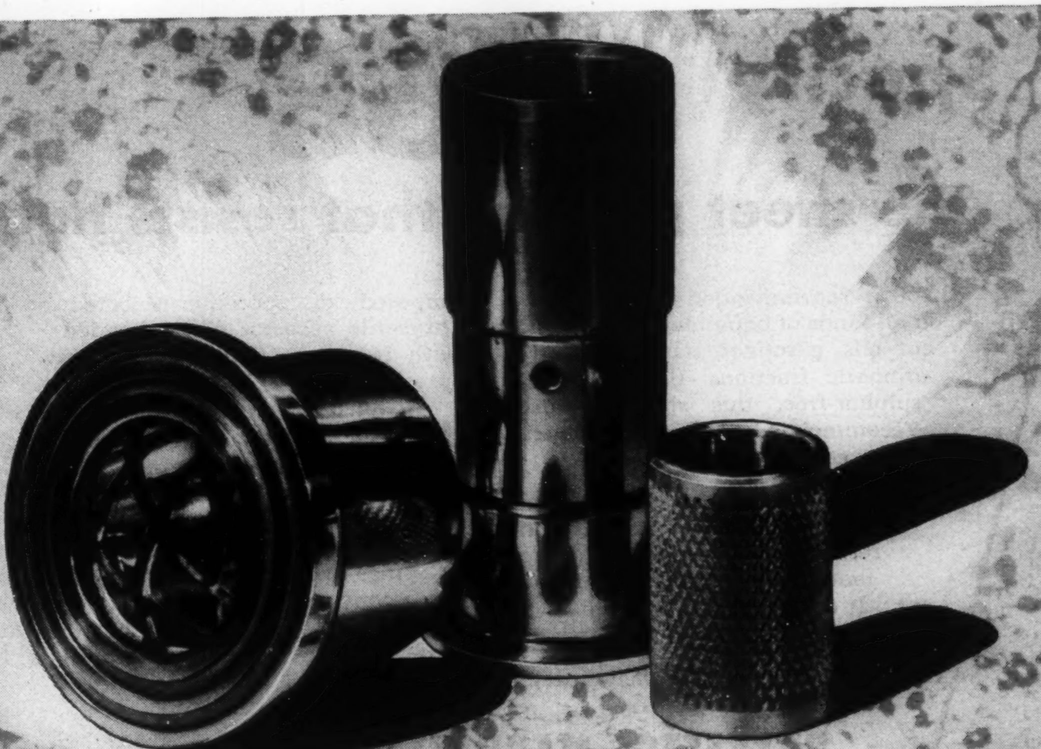
RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

RB&W

Plants at: Port Chester, N.Y., Coraopolis, Pa., Rock Falls, Ill., Los Angeles, Calif. Additional sales offices at: Philadelphia, Detroit, Chicago, Chattanooga, Oakland, Portland, Seattle. Distributors from coast to coast.

38,636 Fasteners are used in 1 American diesel locomotive

104 YEARS MAKING STRONG THE THINGS THAT MAKE AMERICA STRONG



To produce many thousands of cast bronze bearings day after day, to the uniformly high quality synonymous with the name Bunting requires precise foundry control. This control starts with the raw materials necessary for production such as molding and core materials, core binders, fixed carbon fuel, pre-alloyed metal in ingot form purchased to Bunting's own rigid specifications, and virgin metals used for ladle additions to control metal composition. Then, too, melting and casting procedures are carefully controlled.

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Bunting®

BRONZE BEARINGS

BUSHINGS

PRECISION BRONZE BARS

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Specify K-68

the sheet packing that resists hot oil

K-68 is recommended for gaskets on all kinds of equipment handling hot oils, gasolines, naphthas, and aromatic fractions. Because it is sulphur-free, this sheet is also recommended for use in refrigeration equipment.

K-68 was developed for use in aircraft and diesel engines and to resist the solvent action of aromatic oils at high temperatures. It complies with the difficult specification AMS-3232.

This exceptional packing is composed of specially selected Chrysotile asbestos fibres, bonded with Neoprene only, under great pressure.

K-68 is just one of the highly reliable R/M packings made for difficult service in engines, pumps, compressors, valves, and other equipment. Write us for information on the full R/M line of packings and gaskets, and for your free copy of the R/M catalog. Our engineers will be glad to work with you in specifying materials for unusual applications.

RAYBESTOS-MANHATTAN, INC.

PACKING DIVISION, MANHEIM, PA.

Factories: Bridgeport, Conn.; Manheim, Pa.; No. Charleston, S.C.; Passaic, N.J.

RAYBESTOS-MANHATTAN, INC., Manufacturers of Packings • Asbestos Textiles • Mechanical Rubber Products • Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose • Powdered Metal Products • Bowling Balls

K-68
RAYBESTOS MANHATTAN

R/M No. K-68

RAYBESTOS-MANHATTAN, INC. MD-8
Packing Division, Manheim, Pa.

Gentlemen: ☐ **Please send me a free copy of the R/M Packing Catalog.**
☐ **Please send me data on K-68.**

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Company ____________________

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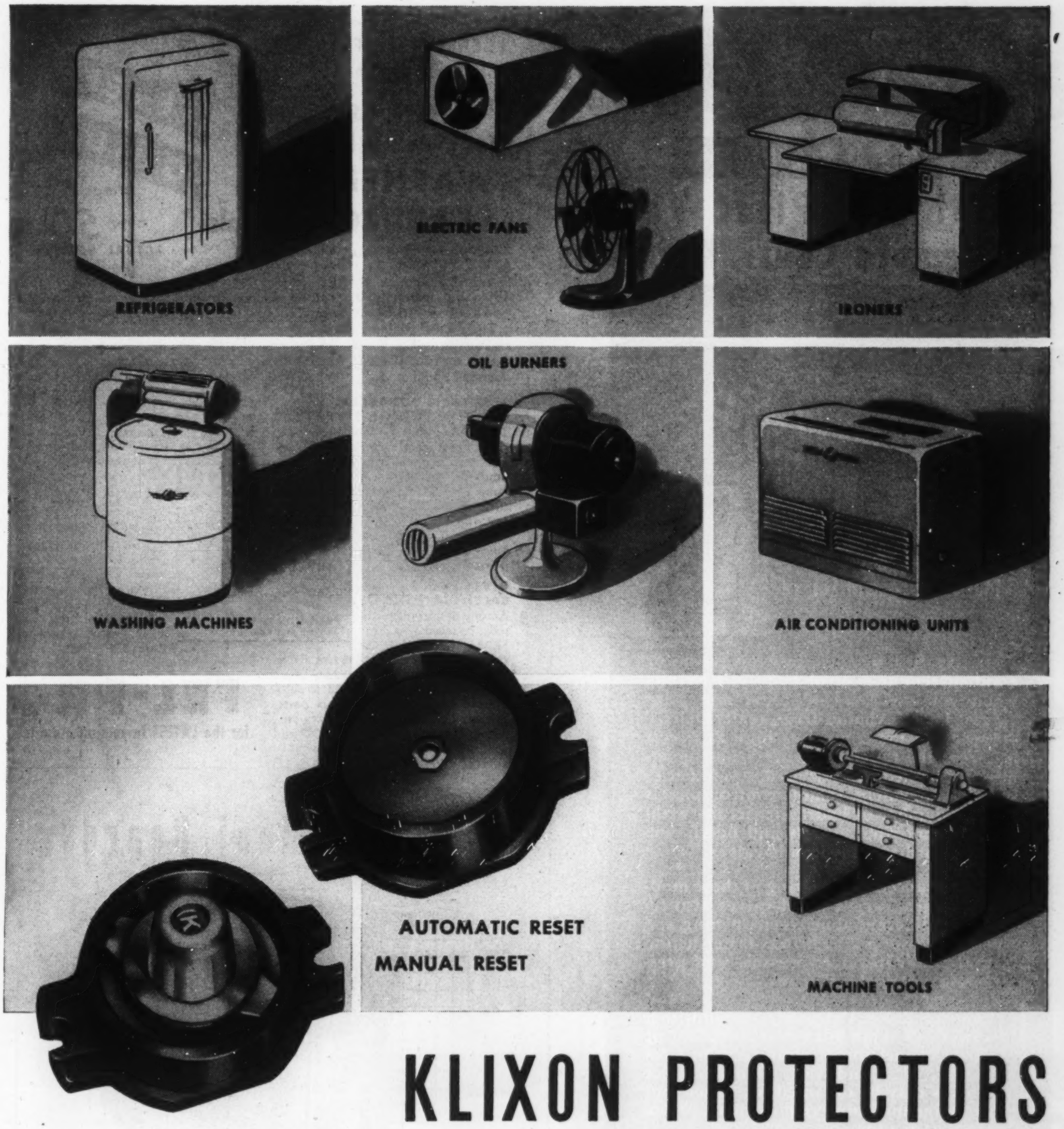
R/M


REFRIGERATORS
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KLIXON PROTECTORS

Assure Long Operating Life by Preventing Motor Burnouts in All Types of Equipment

No matter what the product — machine tools, electric appliances, adding machines, oil burners — you can help build user acceptance by using and specifying motors with built-in Klixon Protectors.

These foolproof devices keep motors operating by eliminating motor burnouts. They take into account the factors that cause motors to overheat and prevent them from burning out by cutting "off" the power when the temperature reaches the danger point. Then when the motor cools sufficiently, they snap "on" the power either automatically or by manual reset depending on the type of protector specified. And because Klixon Protectors are built-in by the motor manufacturer, you get a tested and proven combination of a motor and protector matched to each other assuring safe protection for the life of the motor.

As a user of electrical motors, it will pay you to insist on and buy motors with Klixon Protectors.

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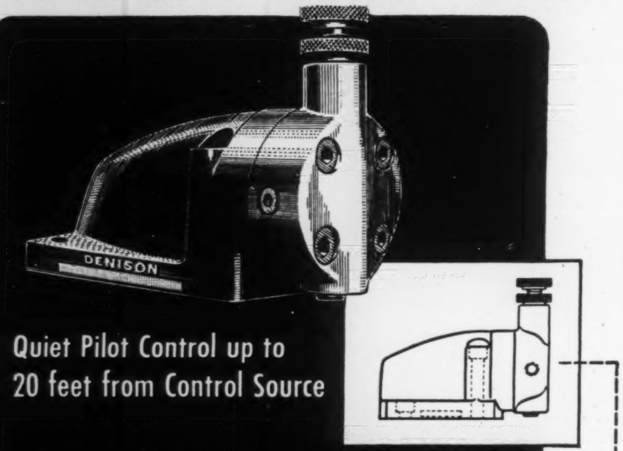
TRADE MARK REG. U. S. PAT. OFF.
SPENCER THERMOSTAT COMPANY
Division Metals & Controls Corp.
2508 Forest St., Attleboro, Mass.

Really Quiet

HYDRAULIC

Relief and Pilot Valves for Remote Control Circuits

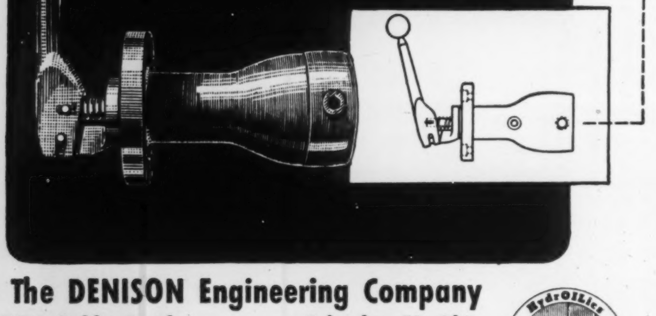


Quiet Pilot Control up to 20 feet from Control Source

YOU GET RID of the noise problem for good in remote-control hydraulic circuits when you use Denison relief and pilot valves. They're chatter-free—really QUIET—even with the control as high as *twenty feet* from the relief valve. And their quietness is matched by their accuracy. You can set up convenient remote-control panels for any number of hydraulic circuits without the annoying squeals and howls you get from ordinary hydraulic valves.

The advanced engineering of these modern, compact, *rugged* relief valves also reduces the differential between opening and closing pressures . . . brings faster action that eliminates over-pressure and pressure-drop troubles.

Denison Relief Valves are available in a variety of types for either subplate or direct connection of piping and in sizes of 3/4", 1 1/4" and 1 1/2". Denison Pilot Valves may be obtained for either foot or flange mounting requirements. Write for details today.



The DENISON Engineering Company
1156 Dublin Road • Columbus 16, Ohio

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FREE GUIDE brings you over **50** ACTUAL SAMPLES!

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The GUIDE contains 50 actual samples of the most commonly-used sealing materials, which Fel-Pro supplies to such leading companies as American Can, Baldwin Locomotive, DuPont, General Electric, Packard, Pure Oil, Quaker Oats, Standard Oil, Western Electric and Westinghouse.

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GIVES FULL SPECIFICATIONS
Among the sample materials contained in this SEALING GUIDE are such newly-developed materials as the revolutionary "Fel-Pro 131". This material is particularly suited to automotive engine parts, chassis parts, pumps, high compression flanges, etc., because of its low swell (just 2%) and exceptional durometer hardness of up to 80 plus or minus 5. Complete specifications are given for each of the 50 material samples, including durometer readings, sheet and roll sizes, applications, etc.

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- **Felbestos 100** for manifold and hot-spot applications!
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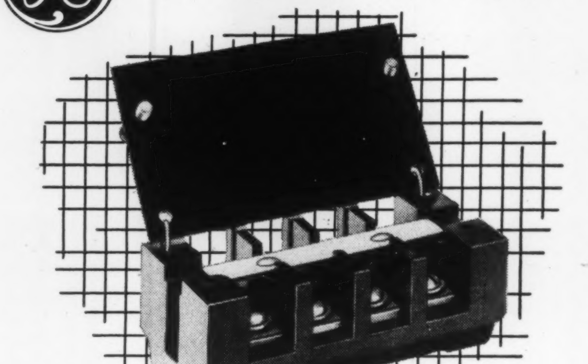
LOOK TO
FEL-PRO
for the LATEST in sealing materials

Terminal Boards



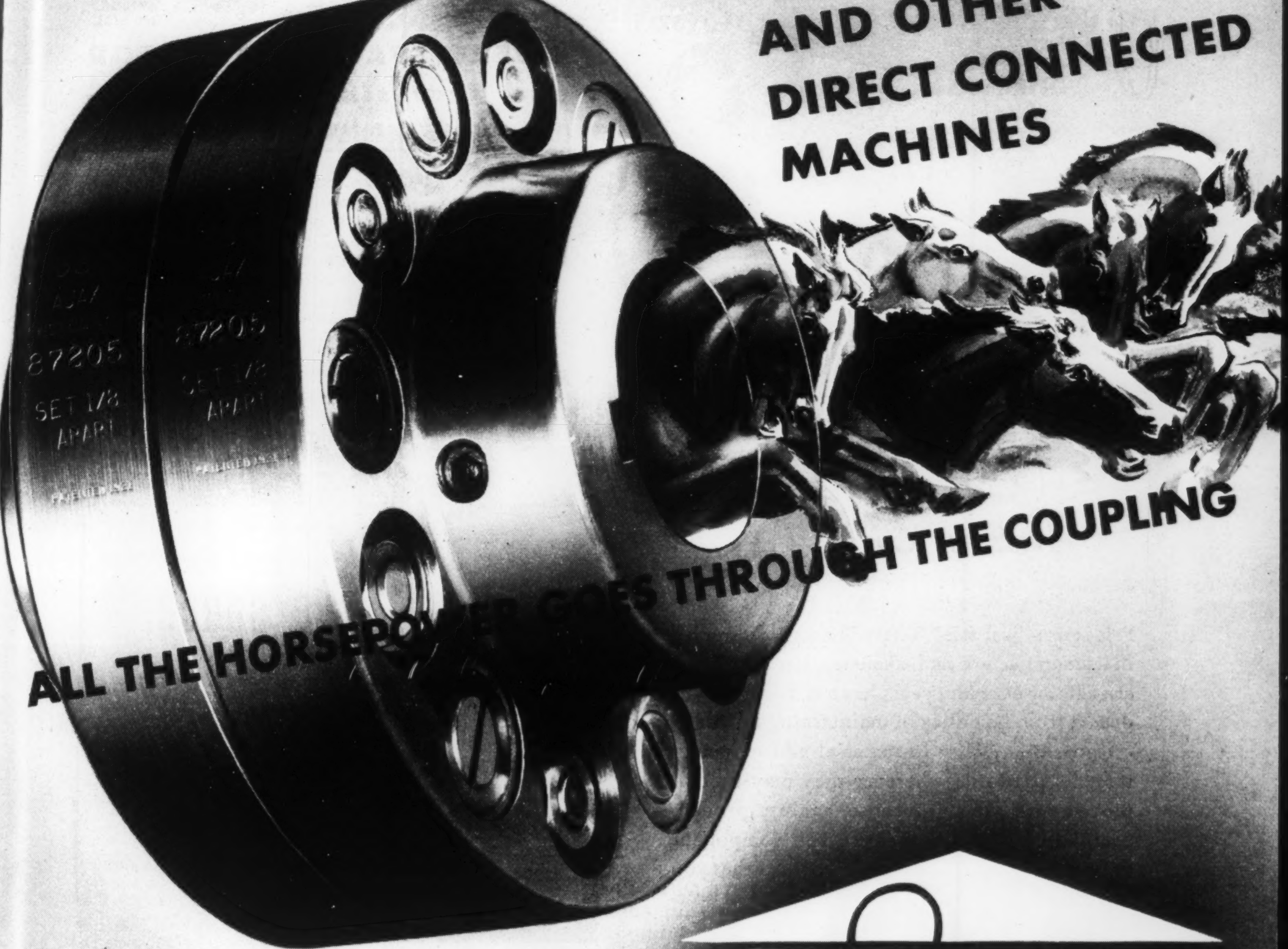
with Hinged Covers

Easy-action hinges on these terminal boards . . . and the connectors really grip the wires and make wiring easy. Marking strips are reversible . . . white on one side, black on the other. Available 4 to 12 poles, 2 inches wide, 1¼ inches high. See your nearest G-E sales representative about these terminal boards. Write for Bulletin GEA-1497. *Apparatus Department, General Electric Company, Schenectady 5, New York.*

GENERAL ELECTRIC

and ON AMERICA'S FINEST PUMPS

AND OTHER DIRECT CONNECTED MACHINES


87205
SET 1/8 APART
87205
SET 1/8 APART
ALL THE HORSEPOWER GOES THROUGH THE COUPLING

● Design engineers and maintenance men everywhere depend on Ajax Flexible Couplings to protect direct driven machines against unavoidable misalignment. Ajax rubber bushed, self-lubricating bronze bearings and steel drive studs provide positive resilient drive. Wide range of types, sizes and capacities. Write for catalog.

AJAX FLEXIBLE COUPLINGS

AJAX FLEXIBLE COUPLING CO. INC. • WESTFIELD, NEW YORK

Also manufacturers of vibrating conveyors, screens and packers and Ajax-Shaler shakers

WESTERN FELT:

Your Insurance Against Complaints

Felt is not "just felt." There is a vast difference in its manufacture and efficiency. Because Western Felt for over fifty years has not, and will not, depart from its policy of maintaining the highest possible quality in material and manufacture, its products, wherever they may be employed, are your insurance against product complaints due to a Western Felt component part. Here are just a few of its features that you can always depend on: range from wool softness to rock hardness—never loses shape—does not ravel or fray—resists oil, water, heat, age—resilient, flexible, compressible—may be cut to extremely close tolerances for small parts—unsurpassed in uniformity. Western Felt engineers with decades of experience in the use of felt stand ready to counsel you.

101F

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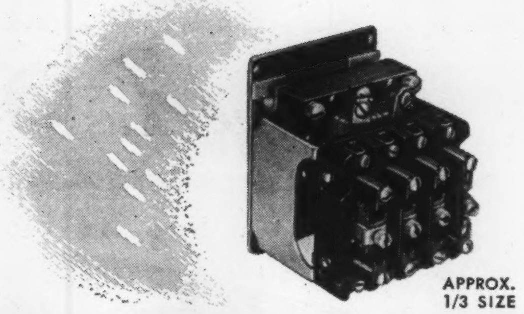
4035-4117 Ogden Ave., Chicago 23, Illinois
Branches in all Principal Cities
Largest Independent Manufacturers and Cutters of wool, hair and jute felts

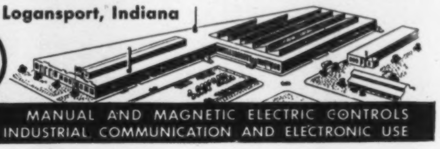


WHERE SPACE IS A FACTOR
and Accessibility a Must—
USE R-B-M INDUSTRIAL CONTACTORS

R-B-M Industrial Contactors, with interchangeable normally open and normally closed contacts, can be mounted in minimum space without sacrificing accessibility. You will also find that the initial low cost of R-B-M, plus long and dependable performance, will save you money.

Available in 10 and 15 ampere sizes, 600 volt A.C., 2 to 8 pole non-reversing—2 to 4 pole reversing. Open and enclosed types. Write for Bulletin and Price List on your company letterhead.

Dept. H-8 R-B-M DIVISION OF ESSEX WIRE CORP.
Logansport, Indiana



RBM
MANUAL AND MAGNETIC ELECTRIC CONTROLS
—FOR AUTOMOTIVE, INDUSTRIAL, COMMUNICATION AND ELECTRONIC USE

how to save space, material and money

By Using

TUTHILL

Stripped Pumps In Your Machinery Designs

TUTHILL
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You'll find many practical suggestions for incorporating the pump directly into the design of your equipment in this Tuthill Stripped Pump bulletin. It presents the two types of stripped pumps available, designed for lubrication, coolant, hydraulic and liquid transfer service. Capacities up to 200 g.p.m. Send for your copy today.

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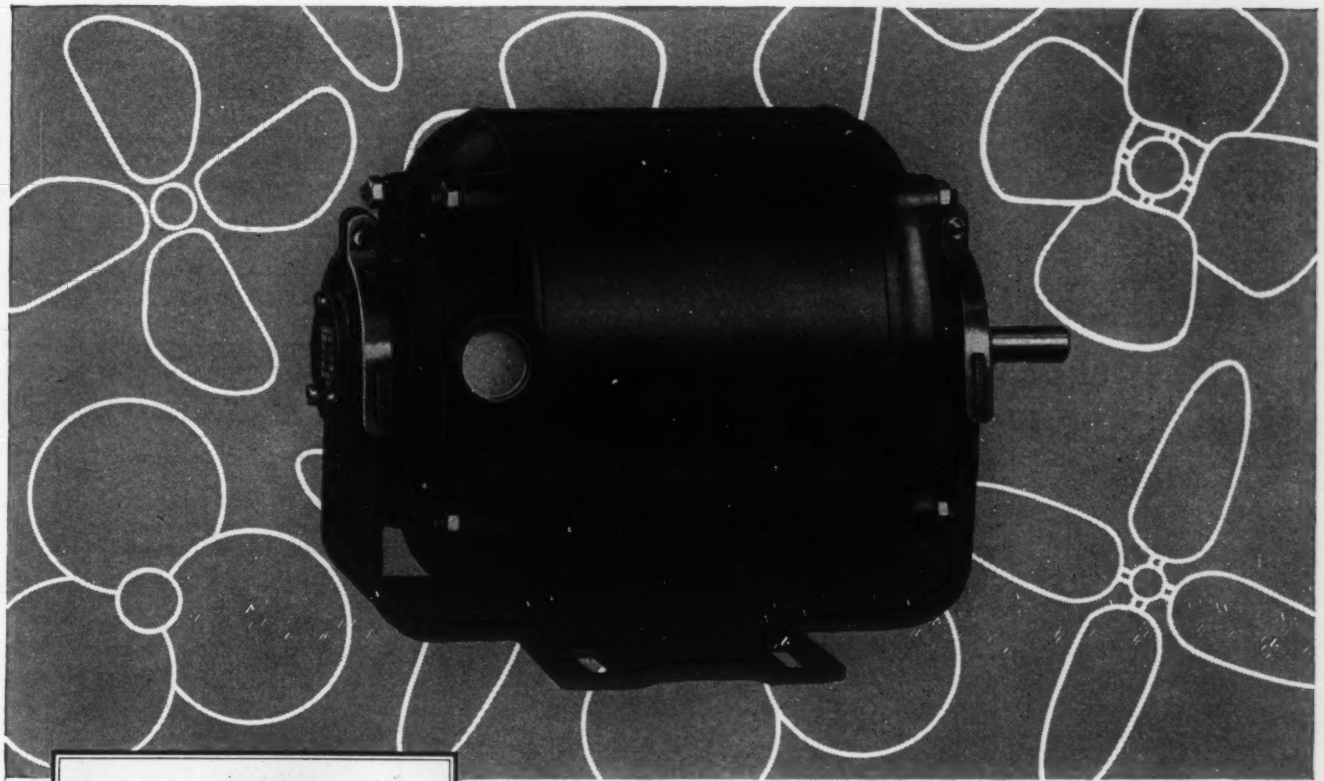
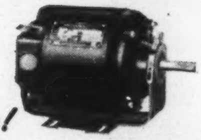
Specify EMERSON-ELECTRIC FAN-DUTY MOTORS

on applications with FAN BLADES mounted on the motor shaft,

to provide these 4 factors

1. **MAXIMUM OPERATING EFFICIENCY**
2. **MAXIMUM MOTOR LIFE**
3. **QUIETNESS**
4. **LESS SERVICING**





New!

Split-phase Blower Motors for Belt-drive Applications

Investigate the advantages of this new line of 1/6, 1/4 and 1/3 h.p. blower motors specifically designed for driving furnace blowers and similar types of air moving equipment.

Write for complete information.

A COMPLETE LINE of Fan-Duty Motors

(1/20 to ¾ h. p.)

Any motor will turn a fan blade . . . for a time. But to get efficient fan operation . . . for the *longest time* . . . at the *lowest cost* . . . under a given set of conditions . . . specify Emerson-Electric Fan-duty Motors.

Emerson-Electric is a pioneer fan and motor manufacturer and offers the most complete fan-duty motor line. These motors are designed with specific provisions for thrust load imposed by a shaft-mounted fan blade and air drawn over the motor. Standard motors include single- and two-speed split-phase, polyphase, permanent split-capacitor, and direct-current types, all with interchangeable mounting dimensions and built to NEMA standards. Available in a wide range of sizes, speeds, and mountings. Emerson-Electric's unique *Twin-gineering Service* will gladly investigate your requirements, without obligation.

FAN DUTY MOTORS

Send Today

for Fan-Duty Motor Bulletin No. 201.

THE EMERSON ELECTRIC MFG. CO.

St. Louis 21, Mo.

EMERSON ELECTRIC

MOTORS • FANS APPLIANCES

REGULAR
Pat'd &
Pats. Pend.

THIN

FLEXLOC

ONE-PIECE
SELF-LOCKING
NUTS

. . . WON'T SHAKE LOOSE
. . . REDUCE MAINTENANCE

Invariably, when nuts loosen, they cause shutdowns, loss of production, and bad tempers all around. All this can readily be eliminated by installing the one-piece, self-locking "FLEXLOC", because *it positively will not shake loose* and positively cuts cost of maintenance.

The all-metal, one-piece resilient "FLEXLOC" is becoming increasingly popular, because it is processed to have an exceptionally uniform torque and, because it packs a stop, lock and plain nut all in one. "FLEXLOC" accommodates itself to a wide range of thread tolerances and can be used over and over again without losing much of its torque. And, being a stop nut, it stays locked in any position on a threaded member. It is not affected by temperatures commonly met within the industrial field of Mechanical Engineering.

Available in "thin" and "regular" types—in sizes from #6 to 2" in diameter—in NC and NF thread series. Write for your copy of the "FLEXLOC" Catalog.

OVER 46 YEARS IN BUSINESS

STANDARD PRESSED STEEL CO.
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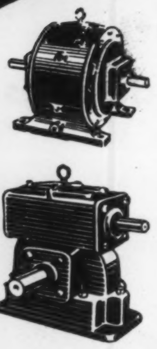
FOR ECONOMICAL AND DEPENDABLE SPEED REDUCTION USE

Abart SPEED REDUCERS



In industry, certain factors of equipment have established themselves as standard, for reliability in longest, severest service. Among these are Abart Speed Reducers—engineered to the most exacting requirements.

Available in worm, spur, or combinations, single and double reduction types, ratios up to 10,000 to 1. Input and output as desired.

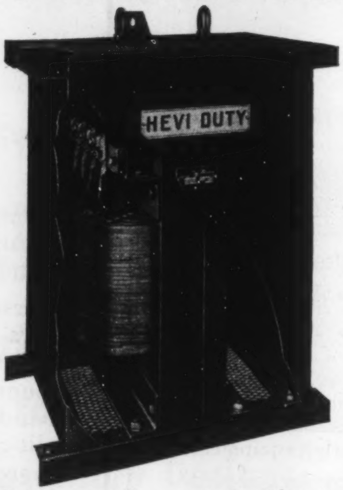
WRITE FOR COMPLETE CATALOG
Illustrates and describes more than 75 types and sizes, 1/50 to 417 h.p. Includes valuable and convenient engineering data and diagrams. Should be in file wherever reducers are used.

Also mfrs. of Abart Gears. No stocks. Send B/P or samples for prompt quotation.

Abart GEAR & MACHINE CO.
4821 W. 16th St. Chicago 50, Ill.

HEVI DUTY ELECTRIC COMPANY

Dry Type Insulating
TRANSFORMERS



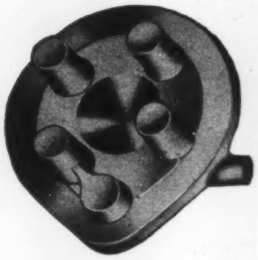
for
Lighting
and small
Power Loads

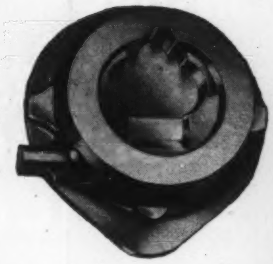
25 KVA
Primary Voltage
480/240
Secondary Voltage
240/120
60 Cycles
Single Phase

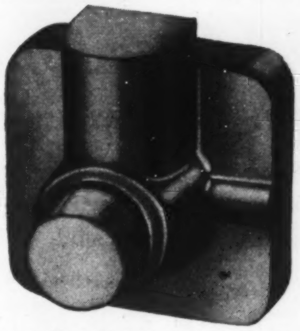
- Floor or wall mounted without changing supports.
- Solderless Connectors save installation time.
- Removable top cover for access to large work space
- Chimney type air space provides better cooling.
- Vacuum impregnated coils for better insulation.
- Sheet metal case gives you better protection.

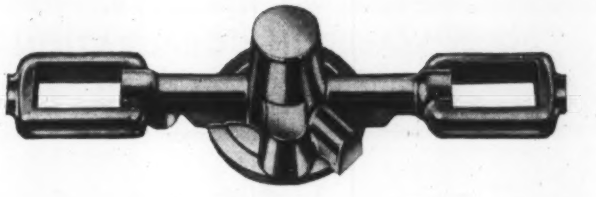
(Other Sizes ¼ - 1000 KVA Available.)

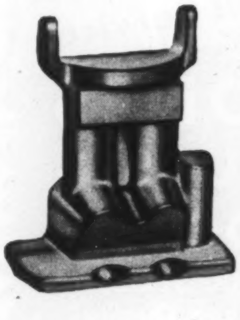
HEVI DUTY ELECTRIC COMPANY
HEAT TREATING FURNACES HEVI-DUTY ELECTRIC EXCLUSIVELY
DRY TYPE TRANSFORMERS — CONSTANT CURRENT REGULATORS
MILWAUKEE 1, WISCONSIN

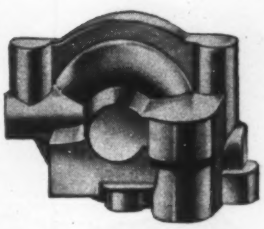


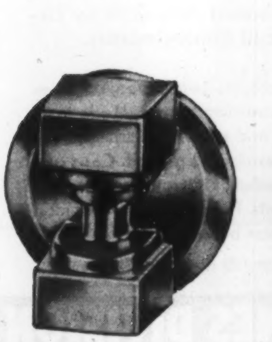












BRASS FORGINGS

are the answer where non-corroding, non-porous materials of great strength are essential

BRASS FORGINGS ARE SUPERIOR IN MANY WAYS TO SAND CASTINGS

LOWER COST: The combination of smoother surfaces, absence of porosity, better machinability, longer tool life, less chucking difficulty, closer tolerances, fewer operations, lighter weight, and practically no scrap, results in the production of a superior product at a lower cost.

Forgings possess about twice the tensile strength of sand castings. Extreme pressures under which the forgings are produced, once during extrusion and again during forging, assures a dense, close-grained material.

Due to the absence of scale, sand, etc. in the metal, forgings can be machined at a higher rate of speed than similar parts made by other processes, and the smoothness of surface, combined with close tolerances, frequently eliminates machining operations. The life of machine tools is greatly increased.

COMPARISON OF COST OF AVERAGE BRASS FORGINGS AND BRASS CASTINGS

(Quoted Figures are approximate)

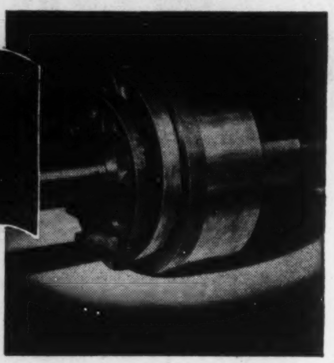
Machined — Ready to polish, buff and plate....... FORGINGS COST 20% LESS
Polish and Buff........ FORGINGS COST 50% LESS
Scrap after Polishing and Buffing......... CASTINGS 7% FORGINGS 0

The Mueller Brass Co. is equipped to forge, completely machine, polish, buff, lacquer or plate. Let us quote you on your product in Forged Brass.

MUELLER BRASS CO.
PORT HURON, MICHIGAN

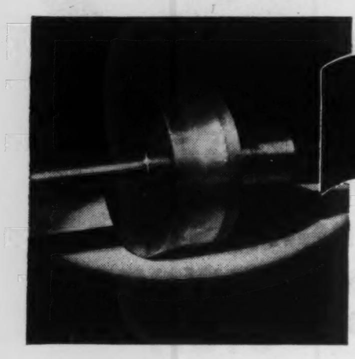
HILLIARD *Clutches*

FOR POWER CONTROL DESIGNS



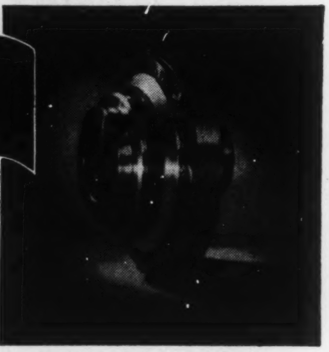
HILLIARD
SINGLE
REVOLUTION
CLUTCH

Unequalled for accurate control of intermittent machine operations — cutting, punching, and packaging. Gives closer tolerances to cut-off, stamping, shearing, and similar machines. Completely automatic; manual, mechanical, or electrical control.



HILLIARD
OVER-RUNNING
CLUTCH

Hilliard Over-Running Clutches and Couplings are automatic in operation. They are unexcelled for automatic two-speed drives, dual drives, stand-by drives, and for allowing machinery to "coast" after drive stops. Excellent as fixed or infinitely adjustable ratchets.



HILLIARD
SLIP
CLUTCH

A reliable series of spring-loaded slip clutches and couplings. Rugged construction with ample friction surface for heavy-duty use. Outstanding for preventing overloads and shocks; for starting heavy loads; as tension drag brakes; for reeling and winding operations; and many other uses.

The HILLIARD Slip Clutch
The HILLIARD
The HILLIARD

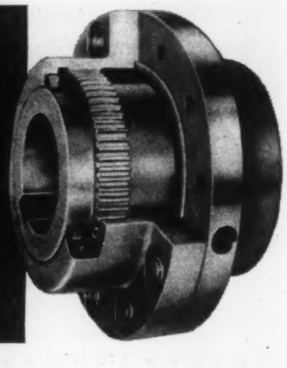
Hilliard's Engineering Department is ready to assist you in designing installations and in selecting the correct clutch or coupling.
Write today — 3 Hilliard Clutch Bulletins with design information. Free on request.

Clutch Makers for over 40 years

The HILLIARD Corporation

103 W. FOURTH ST., ELMIRA, N. Y.
OFFICES IN PRINCIPAL CITIES

INSURE *trouble-free* COUPLING SERVICE



WALDRON Gear Type

ELIMINATES TROUBLE SPOTS OF ORDINARY DESIGNS

Solid Cover Sleeve Non-Welded
No danger of distorting accurate gear in sleeve.

No Metal-To-Metal Wear
to cause leakage and expensive repairs.

Hermetically Sealed
to protect lubricant from exposure to air and dust.

For Full Details, Write For Catalog No. 57.

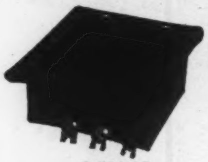
JOHN WALDRON CORPORATION
New Brunswick, New Jersey
Sales Representative In Principal Cities

For HEAVY DUTY WORK!
Severest Electrical Services

JONES PLUGS & SOCKETS

500 SERIES
Proven Quality!

P-506-CE—Plug with Cap



S-506-DB
Socket with deep Bracket

For 5,000 Volts, 25 Amperes per Contact Alterable by circuit Characteristics.

Socket contacts of phosphor bronze, knife-switch type, cadmium plated. Plug contacts hard brass, cadmium plated. Made in 2, 4, 6, 8, 10, and 12 contacts. Plugs and sockets polarized. Long leakage path from terminal, and terminal to ground. Caps and brackets, steel parkerized (*rust-proofed*). Plug and socket blocks interchangeable in caps and brackets. Terminal connections most accessible. Cap insulated with canvas bakelite.

Write for Jones BULLETIN 500 for full details on line.

HOWARD B. JONES DIVISION
Cinch Mfg. Corp.
1026 SOUTH HOMAN AVE. CHICAGO 24, ILL.

Spongex helps both with the family wash!

From toy washing machines to the real thing — in a range of uses as varied as this — *Spongex* sponge rubber is, today, making life smoother and easier for everyone.

In homes, offices and factories . . . in land, sea or air travel . . . wherever you go, whatever you do today, your path is made pleasanter by *Spongex* as an integral part of more and more widely diversified products.

Spongex is used for seals on iron lungs and incubators; for weather strip and rug cushions; for typewriter key pads and refrigerator insulation; for sound deadening on appliances — an infinite number of things, increasing almost daily.

Made by a company which has specialized for 25 years in the production of cellular rubber products, *Spongex* is an amazingly versatile material that is being used by leading manufacturers to solve problems of cushioning, sealing, insulating, gasketing, dust-proofing, shock absorption, and for sound and vibration elimination.

Give this unique material your serious consideration when planning improvements of your present products or developing new ones for future production. Samples available for experimental purposes. Sponge Rubber Products Co., 122, Derby Place, Shelton, Conn. Sales offices in principal industrial centers.

SRp

Trade-Marks Reg. U. S. Pat. Off.

SPONGE RUBBER PRODUCTS CO.

SPONGEX • CELL-TITE • TEXFOAM • TEXLITE • TEXLOCK

ASCO Solenoid VALVES

Effective **Automatic** Control for Cylinders and Power Heads

It's versatile, this ASCO 3-way Solenoid Valve, for it can be found controlling air and hydraulic cylinders on hundreds of different machines, including:

- air, gas and refrigerating compressors (for unloading)
- tire moulding machines
- plastic moulding presses
- furnace and oven doors
- conveyors of many types
- metal working presses

Being "packless," maintenance is negligible. The stainless steel seats and discs (up to 3/8" size) are beveled, tight-seating and renewable. Pipe sizes range from 1/8" to 1/2"; port sizes from 1/8" to 3/8". It's suitable for pressures up to 500 pounds and temperatures up to 212° F. Other ASCO 3-way Valves up to 4" pipe size available.

This ASCO Solenoid Valve (Bulletin 8300) and its many companions in the broad ASCO Line are backed by more than 60 years of experience in the design and manufacture of automatic control units. This is your assurance of (1) getting the correct solenoid valve for your control problem and (2) getting a reliable valve.

When in need of Automatic Transfer Switches, Remote Control Switches, Contactors, Relays, and Specialized Electromagnetic Controls, come to us.

Automatic Switch Co.

387 LAKESIDE AVENUE • ORANGE, NEW JERSEY

Here's Your MOTOR

DRIP PROOF
SPLASH PROOF
BALL BEARING

- **IT'S COOL RUNNING**
- **IT'S ECONOMICAL TO OPERATE**

Selecting a power unit for especially designed machinery or for standard equipment is not a difficult task when you consider that VALLEY MOTORS are built to meet *any* design demand.

Furthermore, you have the added assurance of dependability because of the nationwide acceptance by machinery manufacturers in all industries who have used VALLEY MOTORS for many years.

Why Not Check Into VALLEY Features

VALLEY
ELECTRIC CORPORATION
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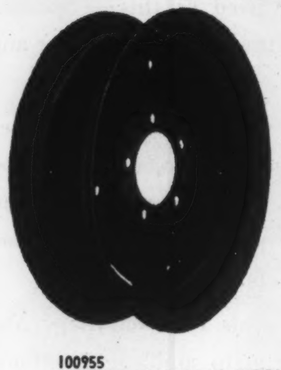
STOP! *Don't throw those old* AUTO TIRES *away*



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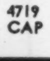

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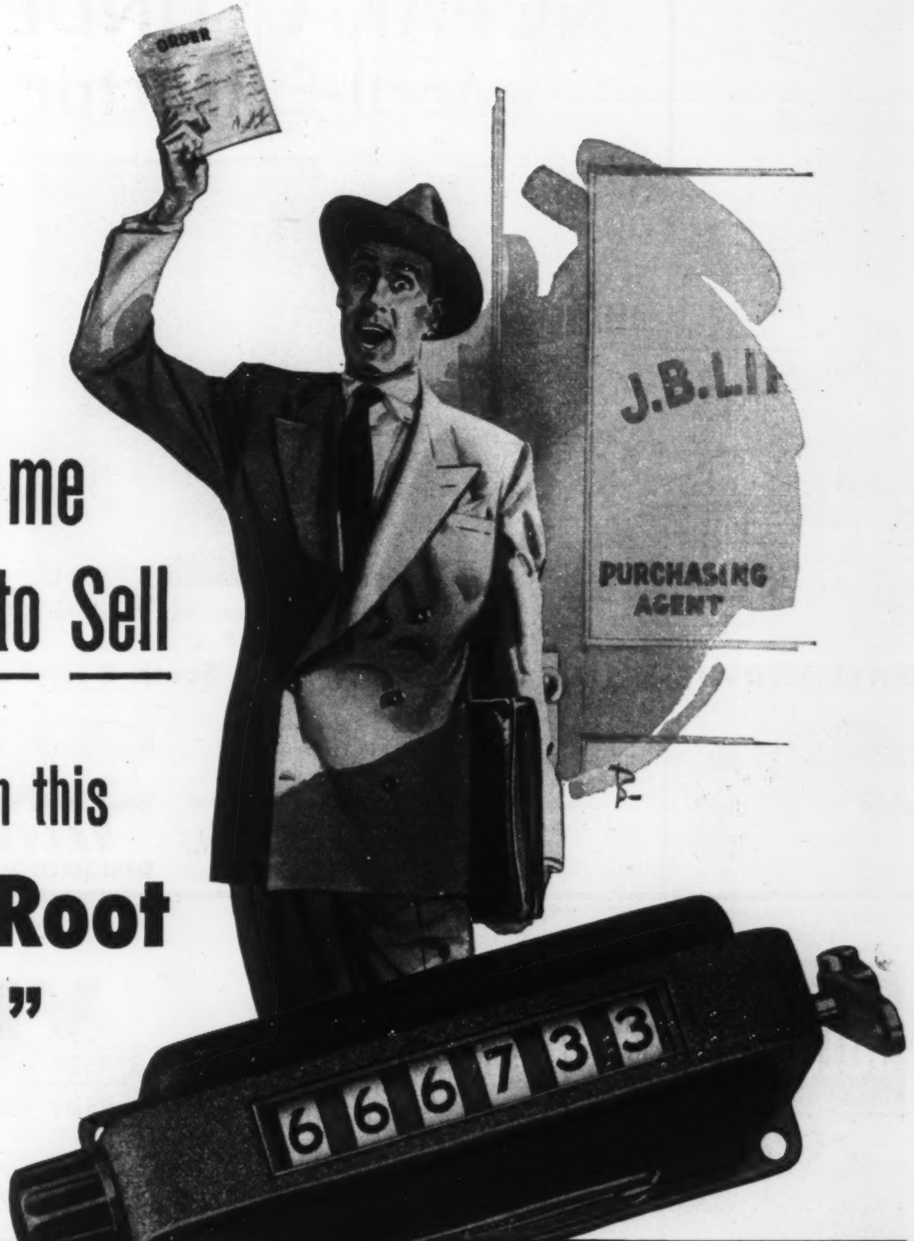

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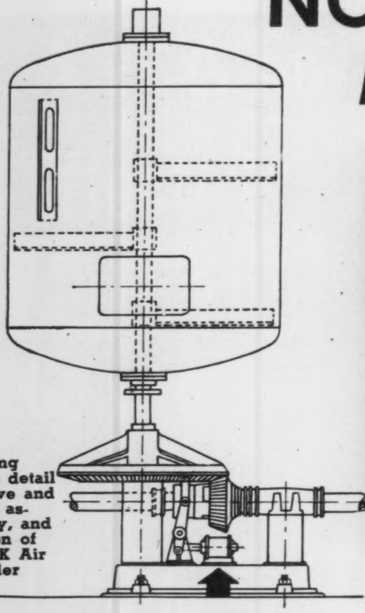

Drawing shows detail of drive and clutch assembly, and location of NOPAK Air Cylinder

Illustration shows NOPAK Model "A" 6" Cylinder which throws clutch in and out

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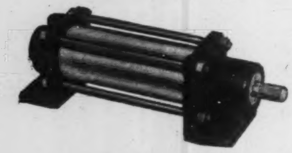

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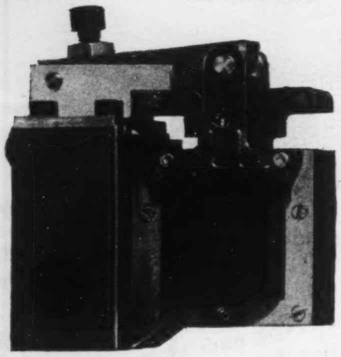

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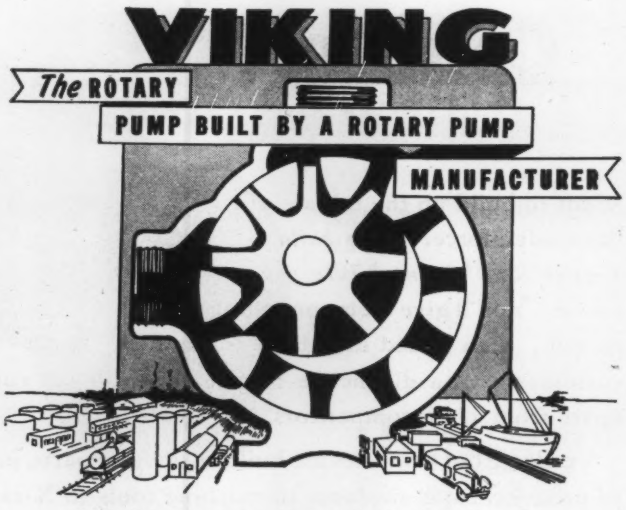

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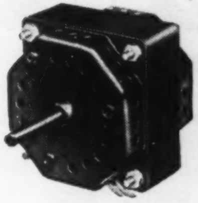

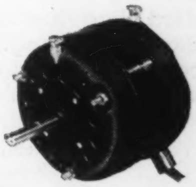

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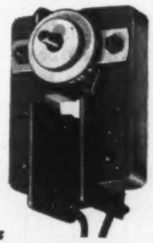

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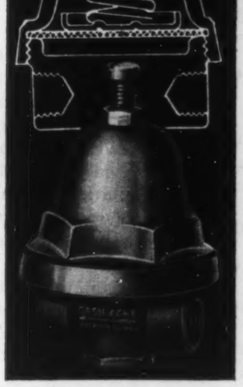

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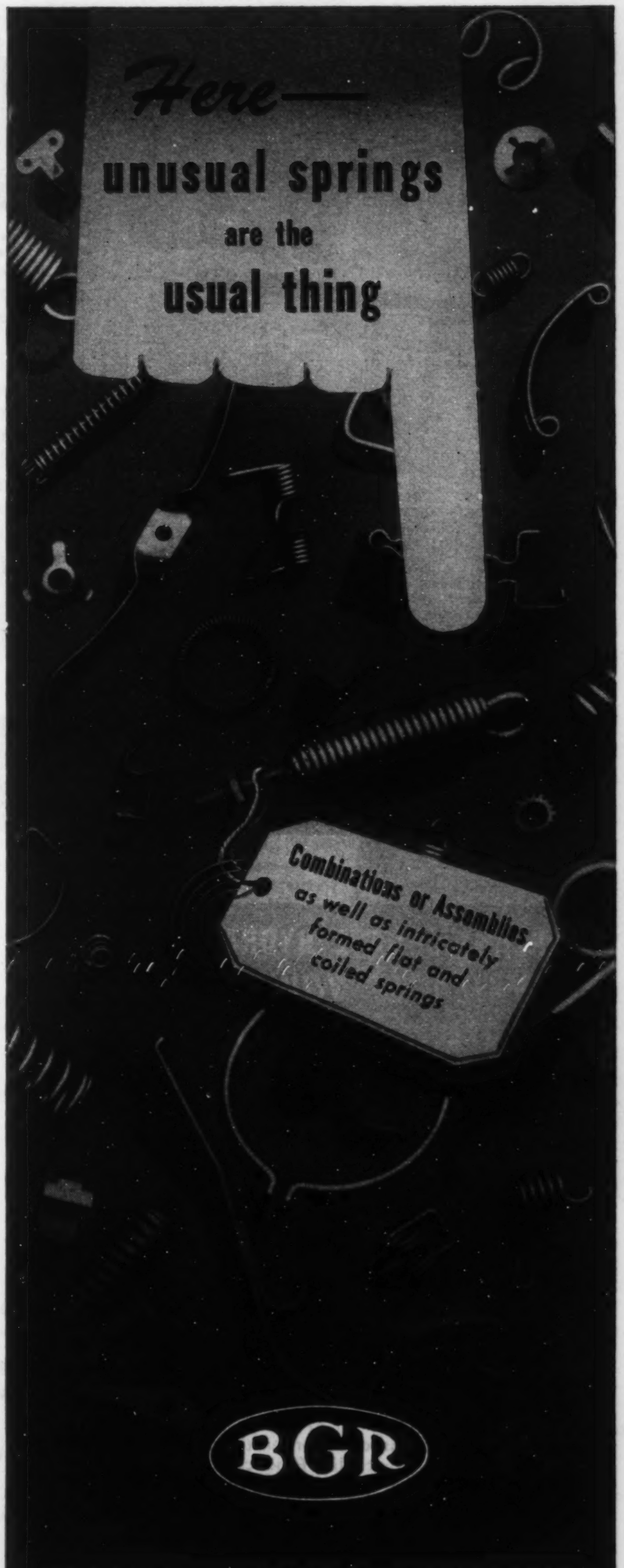
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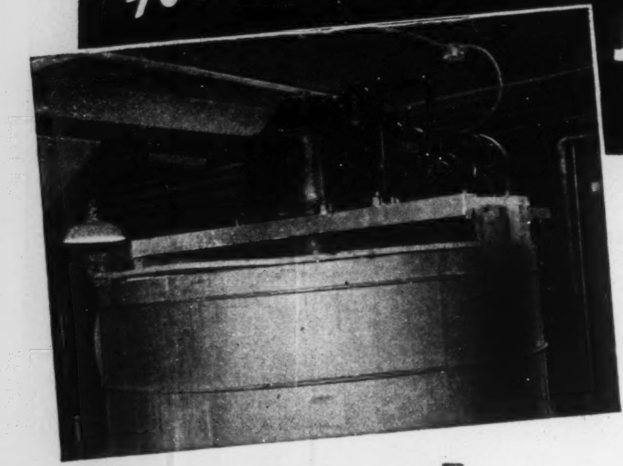

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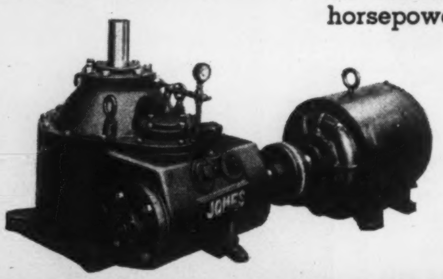

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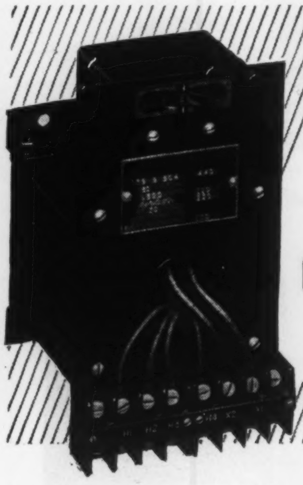

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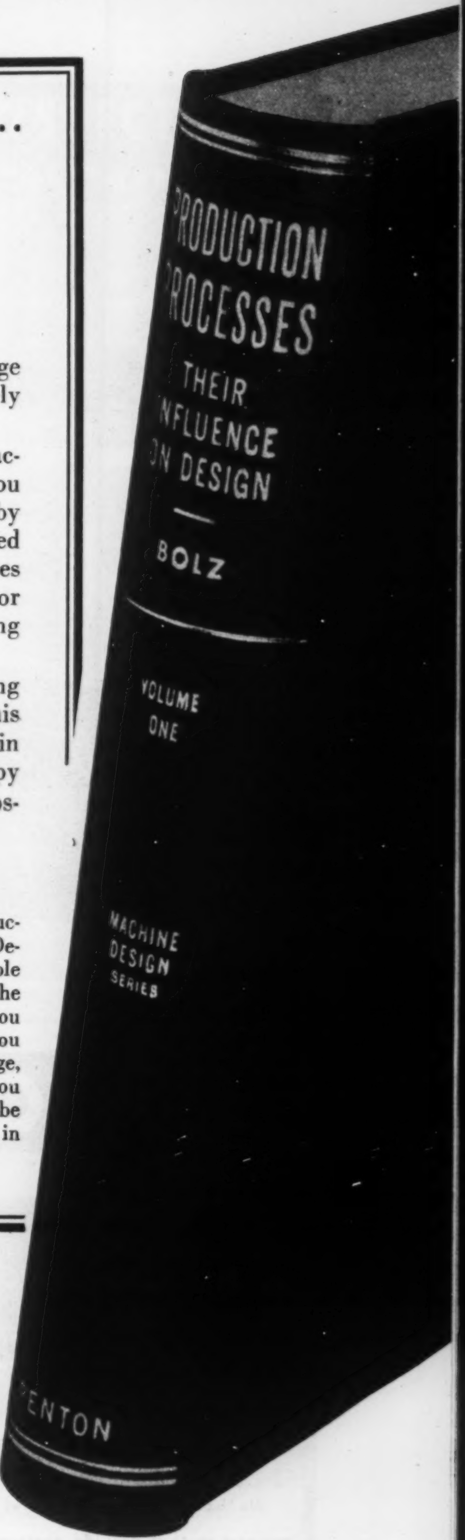

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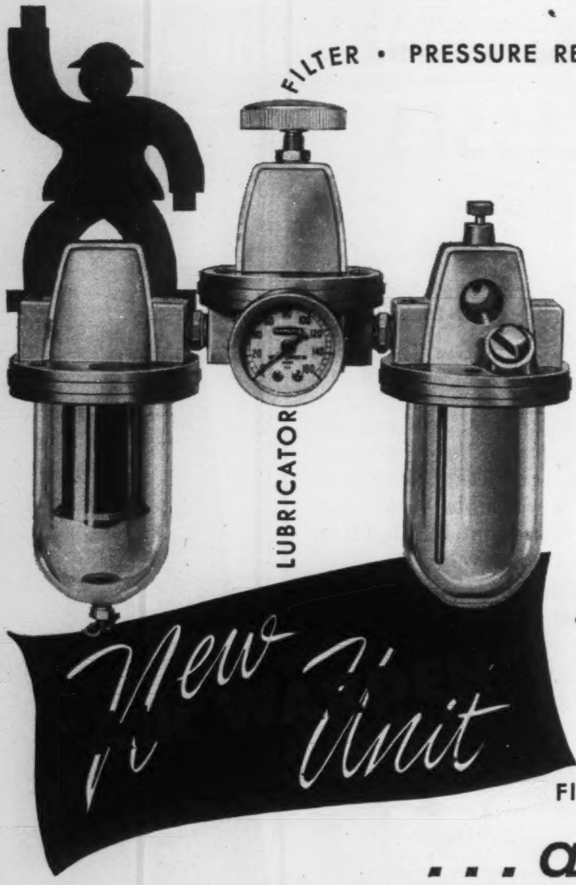

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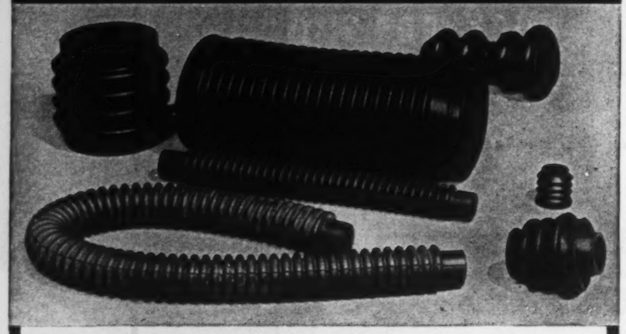

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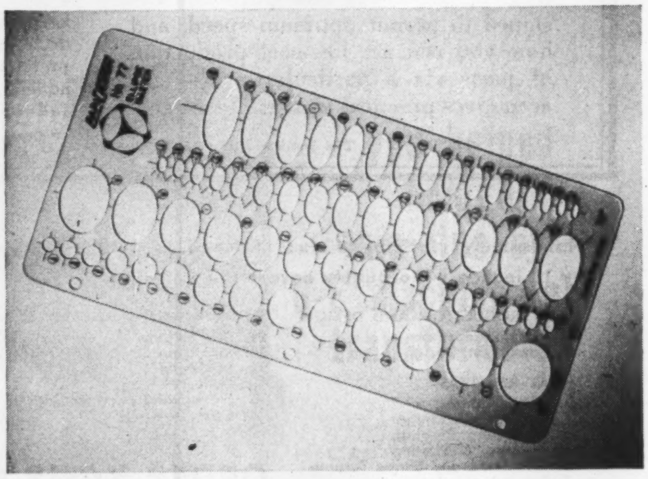

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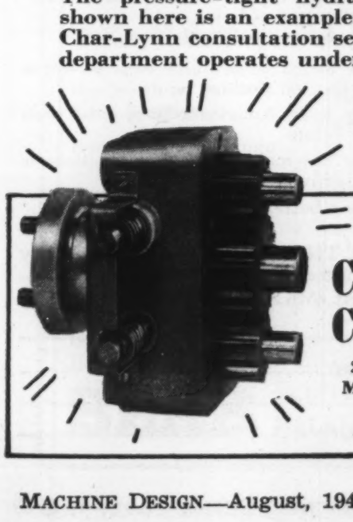

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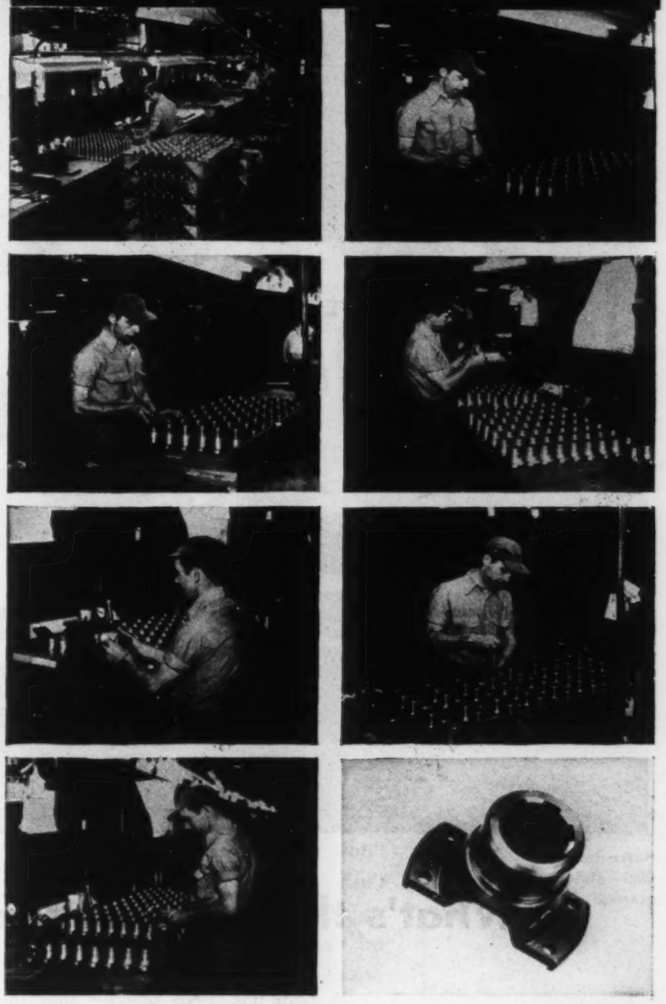

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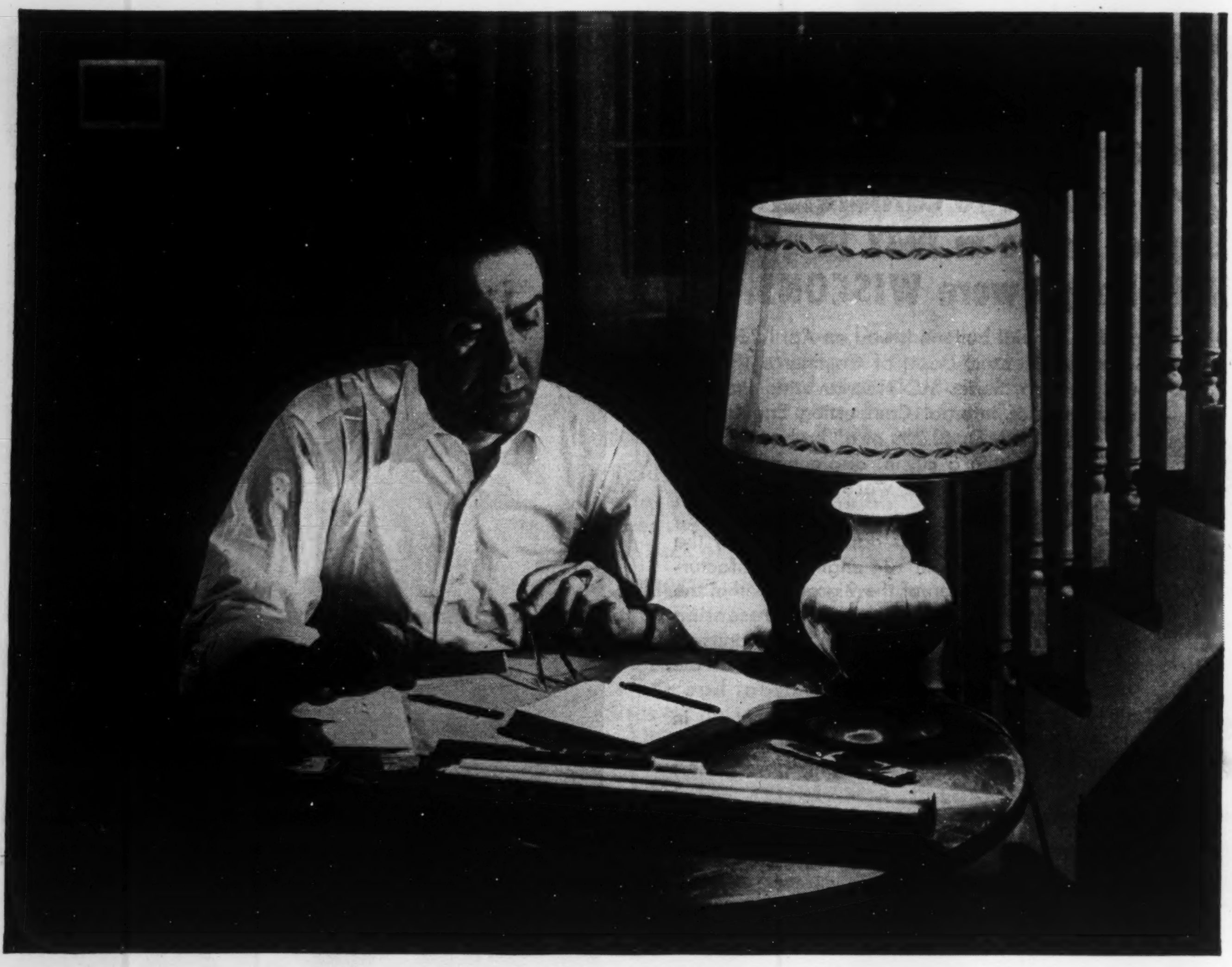

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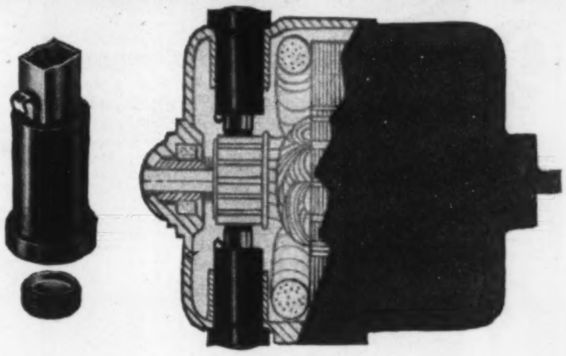

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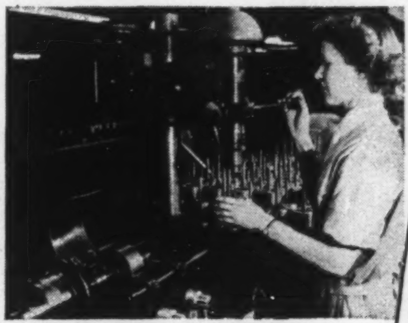

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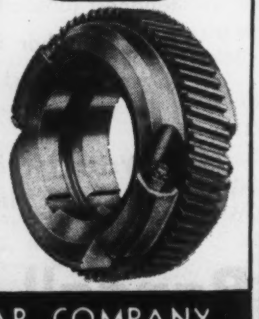

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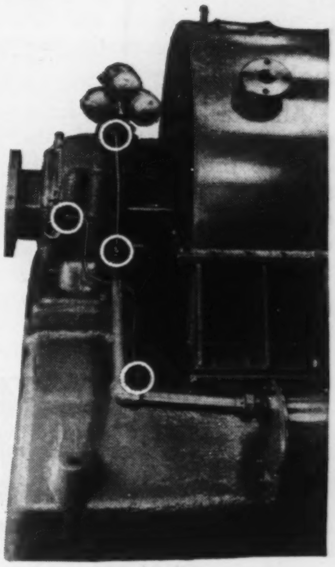

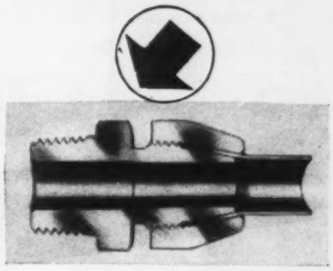

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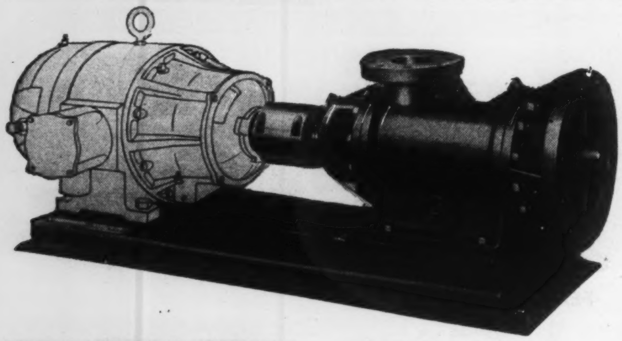

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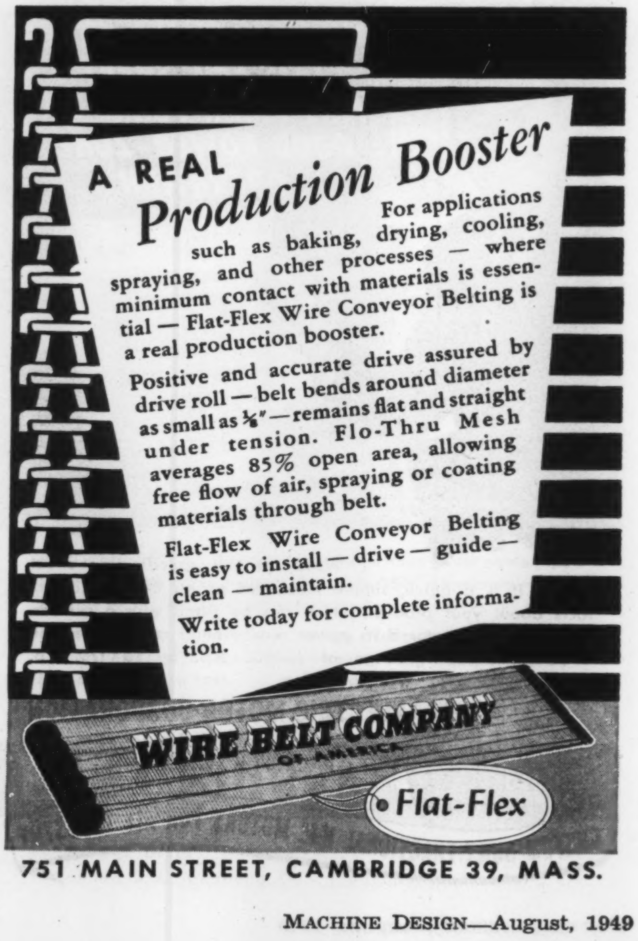

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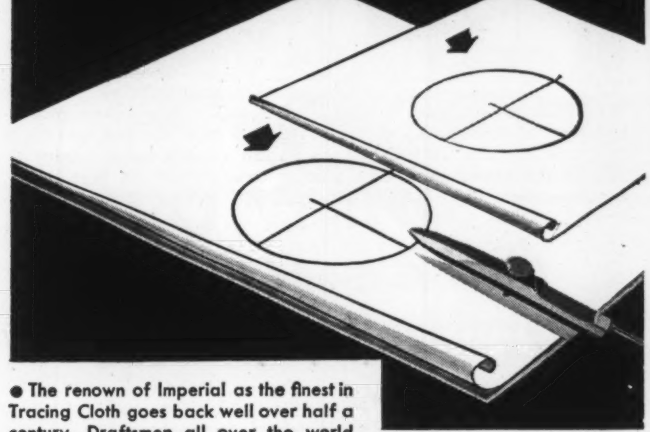

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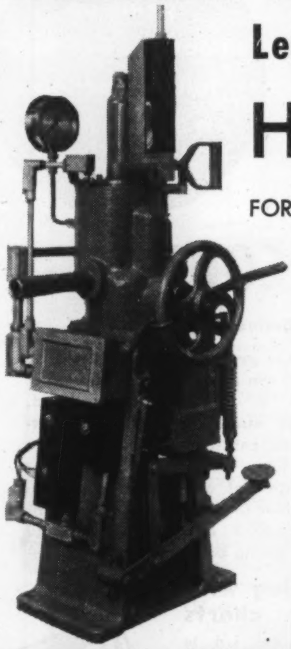

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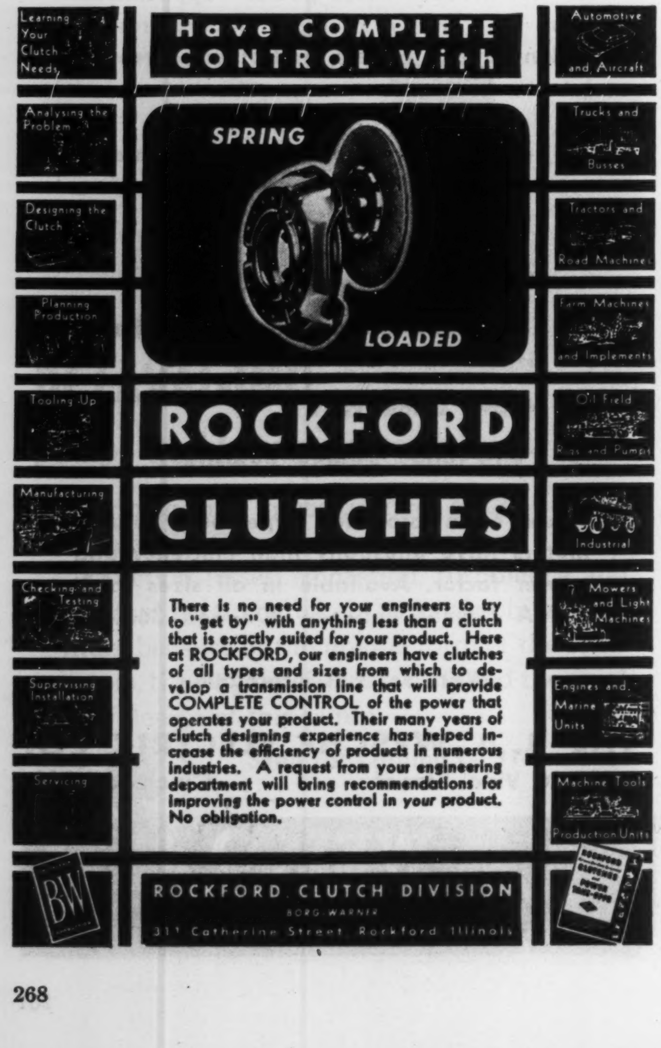
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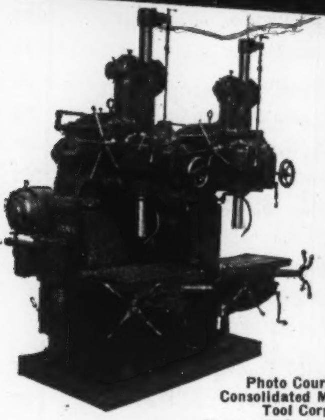

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ADVERTISING INDEX

A

Abart Gear & Machine Co. 250
Accurate Spring Manufacturing Co. 226
Acme Industrial Co. 265
Acushnet Process Co. 260
Advance Foundry Co., The 222
Aeroquip Corp. 185
Ajax Flexible Coupling Co., Inc. 247
Alan Wood Steel Co. 190
Alemite, Division of Stewart-Warner Corp. 165
Allegheny Ludlum Steel Corp. 228
Allen-Bradley Co. 71, 72
Alliance Manufacturing Co. 257
Allis-Chalmers 24, 25
Aluminum Company of America 21, 82
Aluminum Industries, Inc. 199
American Brass Co., The, American Metal Hose Branch 37
American Hard Rubber Co. 200
American Manganese Bronze Co. 267
American Machine and Metals, Inc., United States Gauge Division 32
American Metal Hose Branch, The American Brass Co. 37
American Screw Co. 274
American Steel & Wire Co. 16, 17, 52, 53
American Welding & Manufacturing Co., The 237
Amgears, Inc. 220
Ampco Metal, Inc. 194
Arkwright Finishing Co. 182
Arma Corp. 230
Armstrong Cork Co. 29
Austenal Laboratories, Inc. 55
Automatic Switch Co. 254

B

Babcock & Wilcox Tube Co., The 181
Baldwin-Duckworth Division, Chain Belt Co. 14, 15
Baldor Electric Co. 11
Barco Manufacturing Co. 63
Barnes-Gibson-Raymond, Division of Associated Spring Corp. 257
Barry Corp., The 224
Barth Stamping & Machine Works, Inc. 44
Bear Manufacturing Co. 263
Bound Brook Oil-Less Bearing Co. 170
Bristol Company, The 28
Brown & Sharpe Manufacturing Co. 193
Browning Manufacturing Co. 269
Bruning, Charles, Co., Inc. 49
Bundy Tubing Co. 221
Bunting Brass & Bronze Co., The 243

C

Cambridge Wire Cloth Co. 186
Carnegie-Illinois Steel Corp. 52,53
Cash, A. W., Valve Manufacturing Corp. 257
Char-Lynn Co. 261
Chicago Rawhide Manufacturing Co. 2, 57
Cincinnati Gear Co., The 264
Clare, C. P., & Co. 207
Cleveland Worm & Gear Co., The 81
Clifford Manufacturing Co. 66
Columbia Steel Co. 16, 17, 52, 53
Crane Co. 22
Crucible Steel Company of America 227
Cutler-Hammer, Inc. Inside Front Cover

D

De Laval Steam Turbine Co. 266
Delco Products, Division of General Motors Corp. 201
Denison Engineering Co., The 246
Diamond Chain Co., Inc. 45
Dow Corning Corp. 174

E

Eastman Kodak Co. 167
Eaton Manufacturing Co., Reliance Division 48
Electrical Engineering and Manufacturing Corp. 12
Electric Motor Corp. 265
Electrol, Inc. 208
Emerson Electric Manufacturing Co., The 249
Engineering Manufacturing Co. 264
Erie Bolt & Nut Co. 180

F

Fairbanks, Morse & Co. 88
Fairfield Manufacturing Co. 218
Farrel-Birmingham Co., Inc. 225
Fasco Industries, Inc. 204
Fawick Airflex Co., Inc. 231
Federal Bearings Co., Inc., The 271
Federal-Mogul Corp. 223
Felt Products Manufacturing Co. 246
Flexo Supply Co., Inc. 264
Foote Bros. Gear and Machine Corp. 67
French & Hecht Division, Kelsey-Hayes Wheel Co. 254

G

Galland-Henning Manufacturing Co. 256
Gast Manufacturing Corp. 198
Gear Specialties 23
General Electric Co. 74, 75, 218, 241, 246, 258
Gilmer, L. H., Co. 40
Gisholt Machine Co. 69
Gleason Works 5
Goodrich, B. F., Co., The 4
Gray Iron Founders' Society, Inc. 58
Great Lakes Steel Corp. 87
Greer Hydraulics, Inc. 206
Grinnell Co., Inc. 265

H

Hannifin Corp. 260
Harper, H. M., Co., The 224
Hartford Special Machinery Co., The 73
Haskelite Manufacturing Corp. 36
Hevi Duty Electric Co. 250
Hilliard Corp., The 252
Holtzer-Cabot, Inc. 56
Hoover Ball and Bearing Co. 192
Houghton, E. F., & Co. 31
Howell Electric Motors Co. 203
Hyatt Bearings Division, General Motors Corp. 240
Hydraulic Equipment Co. 60

I

Imperial Pencil Tracing Cloth Co. 267
Indiana Steel Products Co., The 20
International Nickel Co., Inc., The 10

J

Janette Manufacturing Co. 77
Johns-Manville 80
Johnson Bronze Co. 159
Johnson, Carlyle, Machine Co., The 211
Jones & Laughlin Steel Corp. 171
Jones, Howard B., Division Cinch Mfg. Corp. 252
Jones, W. A., Foundry & Machine Co. 258

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ADVERTISING INDEX

K

Keuffel & Esser Co. 84, 85
Kohler Co. 273
Koppers Co., Inc., Fast's Coupling Dept. 59

L

Laminated Shim Co., Inc. 202
LaPlant-Choate Manufacturing Co., Inc. 258
Lauson Co., The 222
Lincoln Engineering Co. 62
Linear, Inc. 195
Link-Belt Company 13
Littleford Bros., Inc. 226
Lord Manufacturing Co. 184
Lovejoy Flexible Coupling Co. 268

Mc

McGill Manufacturing Co., Inc. 46

M

Madison-Kipp Corp. 18
Mahon, R. C., Co., The 68
Manheim Manufacturing & Belting Co. 51
Master Electric Co., The .. Inside Back Cover
Mechanics Universal Joint Division, Borg-Warner Corp. 261
Meehanite Metal Corp. 239
Micro-Switch, A Division of First Industrial Corp. 235
Miller Motor Co. 210
Mitchell-Bradford Chemical Co., The 220
Moraine Products, Division of General Motors Corp. 187
Morganite, Inc. 178
Mueller Brass Co. 251

N

National Bearing Division, American Brake Shoe Co. 19
National Erie Corp. 64
National Motor Bearing Co., Inc. 219
National Screw & Manufacturing Co., The 173
New Departure, Division of General Motors Corp. 6
Norgren, C. A., Co. 183
Norma-Hoffmann Bearings Corp. 83

O

Ohio Gear Co., The 238
Ohio Seamless Tube Co., The 169
Oilgear Co., The 9
Orange Roller Bearing Co. 213
Owens-Corning Fiberglas Corp. 76

P

Parker-Kalon Corp. 39, 41
Peerless Electric Co., The 168
Philadelphia Gear Works, Inc. 232
Phoenix Electric Manufacturing Co. 263
Pure Carbon Co., Inc. 172

R

Racine Tool and Machine Co. 26
Randall Graphite Bearings, Inc. 263
Rapidesign, Inc. 260
Raybestos-Manhattan, Inc., Packing Division 244
R-B-M Division of Essex Wire Corp. 248
Redmond Co., Inc. 54
Reeves Pulley Co. 78, 79
Reliance Division, Eaton Manufacturing Co. 48
Reliance Electric and Engineering Co. 197
Resistoflex Corp. 176
Revere Copper and Brass, Inc. 236
Reynolds Metals Co. 61
Robbins & Myers, Inc. 217
Rockford Clutch Division, Borg-Warner Corp. 268
Roper, Geo. D., Corp. 212
Ross Heater & Manufacturing Co., Inc. 234
Ross Operating Valve Co. 1
Russell, Burdsall & Ward Bolt and Nut Co. 242
Ruthman Machinery Co., The 269

S

Sandusky Foundry and Machine Co. 266
Scintilla Magneto Division of Bendix Aviation Corp. 47, 229
Scovill Manufacturing Co. 163
Shenango-Penn Mold Co. 175
Smith, A. O., Corp. 215
Smith-Armstrong Forge, Inc. 268
Spencer Thermostat Co., Division of Metals & Controls Corp. 245
Sponge Rubber Products Co. 253
Standard Pressed Steel Co. 30, 250
Stewart, F. W., Manufacturing Corp. 266
Superior Tube Co. 196

T

Telechron, Inc. 8
Tennessee Coal, Iron & Railroad Co. 16, 17, 52, 53
Thomson Industries, Inc. 214
Timken Roller Bearing Co., The 65, Back Cover
Tomkins-Johnson Co., The 27
Torrington Co., The 205
Tuthill Pump Co. 248
Twin Disc Clutch Co. 179

U

United-Carr Fastener Corp. 264
United States Gauge, Division of American Machine and Metals, Inc. 32
United States Graphite Co., The 42, 43, 191
United States Steel Corporation Subsidiaries 16, 17, 52, 53
United States Steel Supply Co. 52, 53
United States Steel Export Co. 16, 17, 52, 53

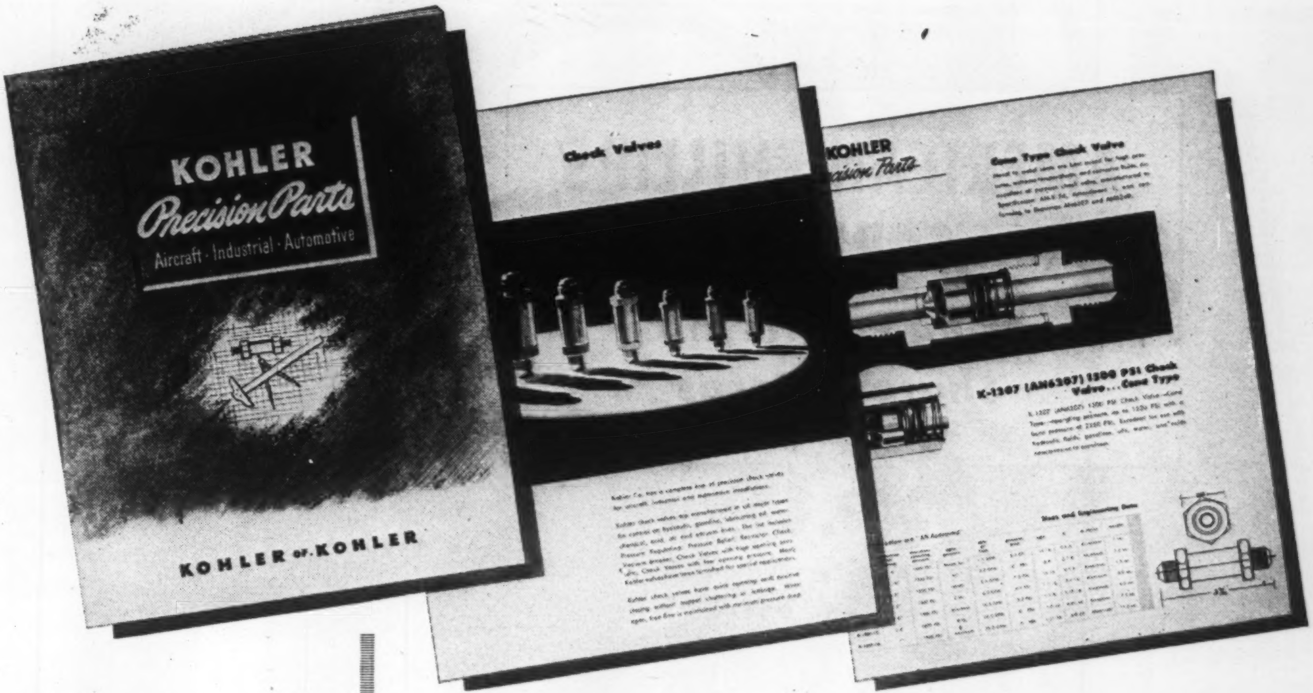
V

Valley Electric Corp. 254
Veeder-Root, Inc. 255
Vickers, Inc. 35
Viking Pump Co. 256

W

Waldron, John, Corp. 252
Ward Leonard Electric Co. 188,189
Warner Electric Brake Manufacturing Co. 177
Waterman Engineering Co. 256
Wesche, B. A., Electric Co., The 267
Western Felt Works 248
Westinghouse Electric Corp. 38, 50, 209
Wheelock, Lovejoy & Co., Inc. 216
Whitney Chain & Manufacturing Co., Division of Whitney-Hanson Industries Inc. 70
Wire Belt Company of America 266
Wisconsin Motor Corp. 261
Wolverine Tube Division, Calumet and Hecla Consolidated Copper Co. 233

Engineers Available or Wanted 268



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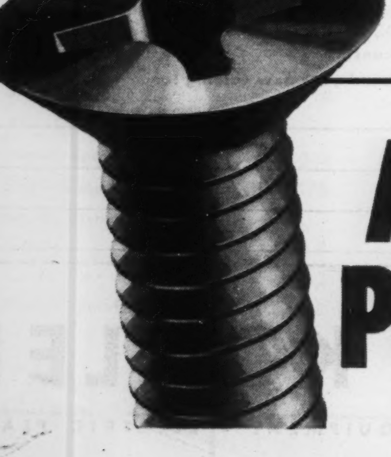

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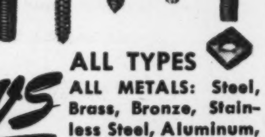

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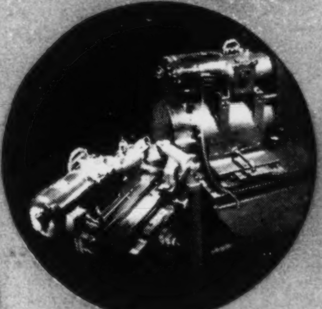

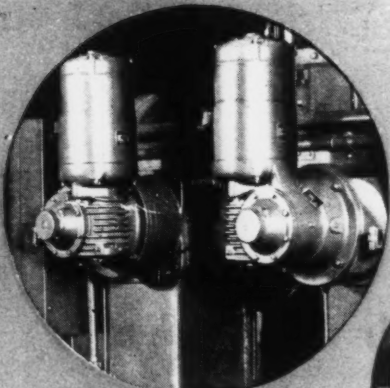

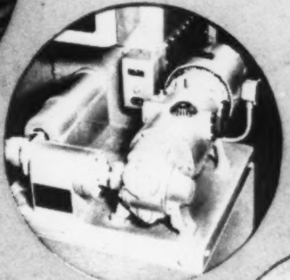

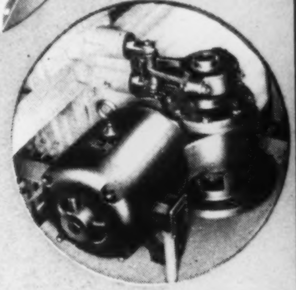

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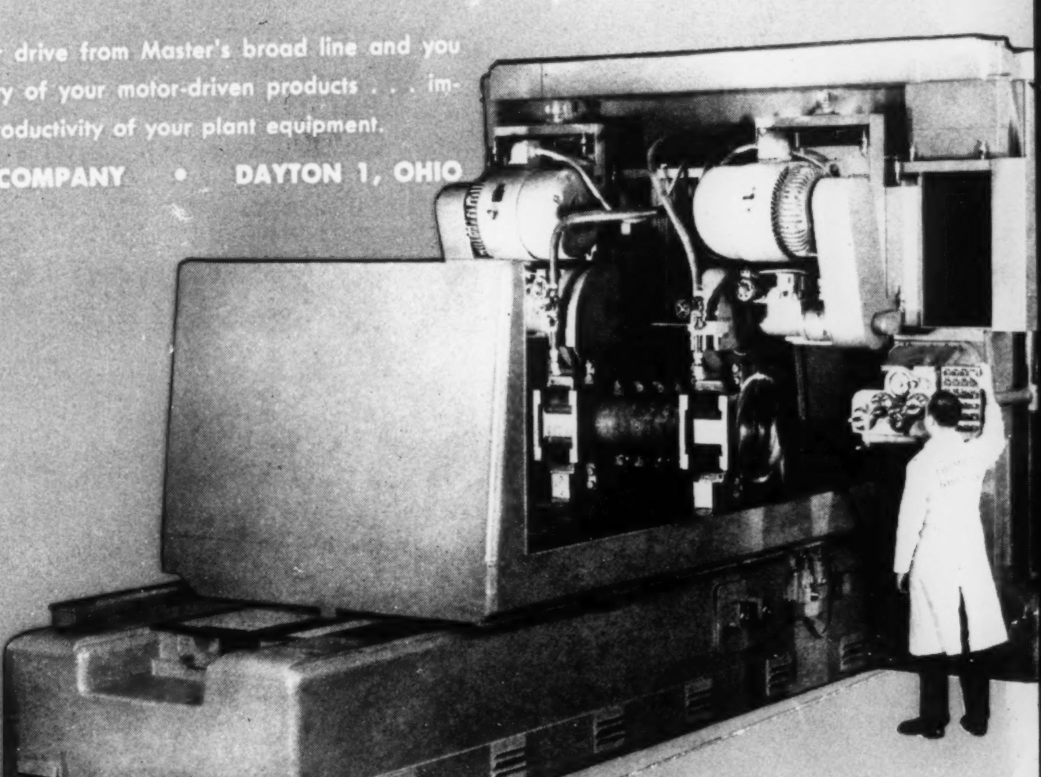

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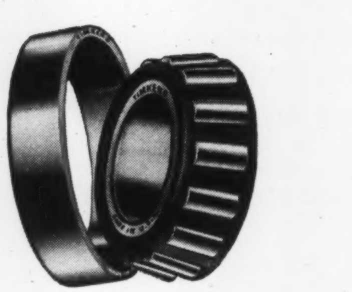

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